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USEC
A Global Energy Company

LA-2605-0001

License Application

American Centrifuge Lead Cascade Facility

at USEC's Facilities in Piketon, Ohio

The American Centrifuge

USEC's Advanced Uranium Enrichment Technology

Docket No. 70-7003

February 2003

LA-2605-0001

LICENSE APPLICATION
FOR THE AMERICAN CENTRIFUGE LEAD CASCADE FACILITY
at USEC's Facilities in Piketon, Ohio

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ACRONYMS AND ABBREVIATIONS

ACL	Administrative Control Level
ACR	Area Control Room
AHJ	Authority Having Jurisdiction
ALARA	as low as reasonably achievable
ANS	American National Society
ANSI	American National Standard Institute
amsl	above mean sea level
ASME	American Society of Mechanical Engineering
ARA	Airborne Radioactivity Area
BCS	Boundary Control Station
BDC	Baseline Design Criteria
BEQ	Baseline Effluent Quantity
BPCV	backpressure control valve
CA	Contamination Area
CAA	Controlled Access Area
CCZ	Contamination Control Zone
CEDE	Committed Effective Dose Equivalent
CFR	*Code of Federal Regulations*
CIT	Corporate Information Technology
CM	Configuration Management
CTTF	Centrifuge Test and Training Facility
DAA	day accumulation area
DAC	Derived Air Concentration
DAW	dry active waste
DBE	design basis earthquake
DFP	Decommissioning Funding Plan
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EML	Environmental Measurements Laboratory
EMSL-LV	Environmental Monitoring System Laboratory at Las Vegas
EP	Emergency Plan
EPA	U.S. Environmental Protection Agency
EPIPs	Emergency Plan Implementing Procedures
ERO	Emergency Response Organization
EV	evacuation vacuum
FCA	Fixed Contamination Area
FDA	Facility Design Authority
FHA	Fire Hazards Analysis
FNAD	Fixed Nuclear Accident Dosimeters
FSRC	Facility Safety Review Committee
GCEP	Gas Centrifuge Enrichment Plant
GDP	gaseous diffusion plant
GET	General Employee Training

HCA	High Contamination Area
HEPA	high efficiency particulate air
HP	Health Physics
HCA	High Contamination Area
HRA	High Radiation Area
HVAC	Heating, Ventilation, and Air Conditioning
ICP/MS	Inductively Coupled Plasma/Mass Spectrometry
IHS	Industrial Hygiene and Safety
IPT	intraplant transporter
IPTT	intraplant tow tractor
IROFS	items relied on for safety
ISA	Integrated Safety Analysis
ISTP	Integrated Systems and Test Plan
LCC	local control center
LEC	Liquid Effluent Collector
LLRW	low level radioactive waste
LO/TO	Lockout/Tagout
LSDA	Lower Suspension and Drive Assembly
MAPEP	Mixed Analyte Performance Evaluation Program
MCW	machine cooling water
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentrations
MDP	machine drive package
MEI	Maximally Exposed Individual
MIV	machine isolation valve
MM	Modified Mercalli
MSDS	Material Safety Data Sheet
MSL	mean sea level
M&TE	maintenance and test equipment
MVIP	machine variable instrument package
NCS	Nuclear Criticality Safety
NCSA	Nuclear Criticality Safety Approval
NCSE	Nuclear Criticality Safety Evaluation
NEPA	National Environmental Protection Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Health and Safety
NIST	National Institute of Standards and Technology
NMSZ	New Madrid seismic zone
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NS&Q	Nuclear Safety and Quality
NVLAP	National Voluntary Laboratory Accreditation Program
ODNR	Ohio Department of Natural Resources
OJT	on-the-job training
OSHA	Occupational Safety and Health Administration

PGA	peak ground acceleration
PGDP	Paducah Gaseous Diffusion Plant
PB1	X-3001 Process Building
PBT	Performance Based Training
PM	preventive maintenance
PMF	Probably Maximum Flood
PMT	post-maintenance testing
PORTS	Portsmouth Gaseous Diffusion Plant
PPE	personal protective equipment
PSB	Process Support Building
PSM	Process Safety Management
PSS	Plant Shift Superintendent
PTI	permits-to-install
PV	purge vacuum
QA	Quality Assurance
QAPD	Quality Assurance Program Description
QC	Quantity Control
QL	Quality Level
RCRA	*Resource Conservation and Recovery Act* of 1976
RCW	recirculating cooling water
REIRS	Radiation Exposure Information Reporting System
RG	Regulatory Guide
RMA	Radioactive Material Area
RMDC	Records Management and Document Control
RMP	Risk Management Program
RP	Radiation Protection
RPM	Radiation Protection Manager
RQ	Reportable Quantity
RWP	Radiation Work Permit
RGA	Regional Gravel Aquifer
RHW	recirculating heating water
RM	river mile
R/A	Recycle/Assembly
SAR	Safety Analysis Report
SARA	*Superfund Amendments and Reauthorization Act*
SCBA	self-contained breathing apparatus
SME	Subject Matter Expert
SPCC	Spill Protection Control and Countermeasures
STP	Sewage Treatment Plant
SRD	System Requirements Document
SRP	Standard Review Plan
SSCs	structures, systems, and components
TDAG	Training Development and Administrative Guide
TEDE	Total Effective Dose Equivalent
TLDs	Thermoluminescence Dosimeters
TQs	Threshold Quantities

TRM	Training Requirement Matrices
TSD	Treatment, Storage, or Disposal
TWCR	Tower Water Cooling Return
TWCS	Tower Water Cooling Supply
UCNI	Unclassified Controlled Nuclear Information
UCRS	upper continental recharge system
USA	Upper Suspension Assembly
USEC	USEC Inc.
USGS	U.S. Geological Survey
VHRA	Very High Radiation Area

CHEMICALS AND UNITS OF MEASURE

cfs	cubic feet per second
Ci	curie
cm	centimeters
cm^2	square centimeter
dpm	disintegration per minute
F	Fahrenheit
ft	feet
ft/d	feet per day
ft^2	square feet
g	grams
Gal	gallons
Gal/d	gallons per day
HF	hydrogen fluoride
in.	inches
k_{eff}	$k_{effective}$
km	kilometers
km^2	square kilometers
kV	kilovolts
L	liters
lb	pounds
L/d	liters per day
lfpm	linear feet per minute
m	meters
m^2	square meters
mCi	millicuries (one-thousandth of a curie)
mCi/mL	millicuries per milliliter
mg	milligram (one-thousandth of a gram)
mg/L	milligrams per liter
mph	miles per hour
mrem	millirem (one-thousandth of a rem)
pCi	picocurie (one-trillionth of a curie)
pCi/L	piocuries per liter
ppm	parts per million
psi	Pounds per square inch
rem	roentgen equivalent man
SWU	separative work units
UF_6	uranium hexafluoride
wt.	weight
YA	Instrument Air
μCi	microcurie (one-millionth of a curie)
μCi/g	microcuries per gram
μg	microgram (one-millionth of a gram)
μg/kg	micrograms per kilogram
μg/L	micrograms per liter

$\mu g/mL$	micrograms per milliliter
$\mu g/m^3$	micrograms per cubic meter
μ	micron or micrometer (one-millionth of a meter)

EXECUTIVE SUMMARY

This license application was prepared by USEC Inc. (USEC), the applicant for a license to possess and use special nuclear, source, and by-product material in the American Centrifuge Lead Cascade Facility (hereafter referred to as the Lead Cascade) at the Portsmouth Gaseous Diffusion Plant (PORTS) located in Piketon, Ohio under the *Atomic Energy Act* of 1954, as amended, 10 *Code of Federal Regulations* (CFR) Part 70, and other applicable laws and regulations. USEC is the parent company of the United States Enrichment Corporation, which is the current holder of a U. S. Nuclear Regulatory Commission (NRC) Certificate of Compliance for PORTS issued under 10 CFR Part 76. USEC is a global energy company and the world's leading supplier of enriched uranium fuel.

The Lead Cascade is a test and demonstration facility designed to provide information on American Centrifuge enrichment technology. The Lead Cascade is an important step toward advancing the national energy security goals of maintaining a reliable and secure domestic source of enriched uranium. These goals are consistent with the purposes for which the Corporation was created. Through amendments to the *Atomic Energy Act*, Congress created the Corporation to, among other things, conduct research and development, as required, to evaluate alternative technologies for uranium enrichment, and to help maintain a reliable and economical domestic source of enriched uranium.

USEC is responsible for the design, fabrication, installation, operation, maintenance, modification, and testing of the Lead Cascade. The goal of the project is to provide reliability, performance, cost and other data vital to making decisions concerning the deployment of a Commercial Plant and to reduce the financial risk of such deployment. The Lead Cascade operates up to 240 centrifuge machines in the recycle mode as a "closed loop" system, where the enriched product stream is recombined with the depleted stream prior to being re-fed to the cascade. The Lead Cascade uses full-scale equipment and laboratory samples are withdrawn to confirm the enrichment process. It is operated so that no enriched material is withdrawn, other than laboratory samples. The Lead Cascade may possess up to 250 kilograms uranium hexafluoride and may enrich uranium up to 10 weight percent ^{235}U. The design of the Lead Cascade complies with the Baseline Design Criteria specified in 10 CFR 70.64(a) and the defense-in-depth requirements contained in 10 CFR 70.64(b).

The Lead Cascade is located on U.S. Department of Energy (DOE)-owned land in rural Pike County, a sparsely populated area in south central Ohio. The facilities will be leased to USEC. The PORTS reservation has been studied and characterized extensively by both DOE and USEC. The facilities utilized for the Lead Cascade, which are part of the former DOE Gas Centrifuge Enrichment Plant program, were built in the early 1980s. No new facilities will be constructed because the infrastructure needed to operate a Lead Cascade is already in place. The existing facilities will be refurbished to accommodate the Lead Cascade. In addition, the Lead Cascade will use other existing site-wide services such as laboratory analysis, fire protection, security, medical, emergency management, waste management, and environmental monitoring.

This license application follows the format and guidelines provided in NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*. The Application is written prospectively in the present tense, representing the licensed condition. The information provided reflects the design in sufficient detail to enable a reviewer to make a definitive evaluation that the Lead Cascade can be constructed and operated without undue risk to the health and safety of the public and with no significant impact to the environment.

1.0 GENERAL INFORMATION

The USEC Inc. (USEC) American Centrifuge Lead Cascade Project (hereafter referred to as the Lead Cascade) encompasses installation and operation of up to 240 gas centrifuge machines within existing buildings, located on the site of the Portsmouth Gaseous Diffusion Plant (PORTS). PORTS is operated by USEC's wholly owned subsidiary, the United States Enrichment Corporation (Corporation), under a Certificate of Compliance issued by the U.S. Nuclear Regulatory Commission (NRC) pursuant to 10 *Code of Federal Regulations* (CFR) Part 76. The goal of the project is to provide reliability, performance, cost and other data vital to making decisions concerning the deployment of a Commercial Plant and to reduce the financial risk of such deployment. The facility may enrich uranium up to 10 weight (wt.) percent ^{235}U. The cascade is operated on recycle where the enriched product stream is recombined with the depleted stream prior to being re-fed to the cascade. Samples are taken for laboratory analysis. USEC's possession limit of uranium hexafluoride (UF_6) for the Lead Cascade is 250 kilograms (kg). The Lead Cascade's license authorizes operation for a period of five years.

This license application follows the format and guidelines provided in NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility.* The Application is written prospectively in the present tense, representing the licensed condition. The information provided reflects the design in sufficient detail to enable a reviewer to make a definitive evaluation that the facility can be constructed and operated without undue risk to the health and safety of the public and with no significant impact to the environment.

1.1 Facility and Process Description

The Lead Cascade operates up to 240 centrifuge machines in the recycle mode as a "closed loop" system, where the enriched product stream is recombined with the depleted stream prior to being refed to the cascade. Additional centrifuges may be available for other uses, but are not installed for operation (e.g., spares). The Lead Cascade uses full-scale equipment and laboratory samples are withdrawn to obtain information on American Centrifuge enrichment technology. The Lead Cascade is operated so that no enriched material is withdrawn, other than laboratory samples. No finished product is produced by the Lead Cascade.

1.1.1 Facility Layout

The Lead Cascade is located within the USEC leased area of the U.S. Department of Energy's (DOE) PORTS reservation depicted in Figure 1.1-1 (located in Appendix A of this license application). The facilities utilized for the Lead Cascade, which are part of the former Gas Centrifuge Enrichment Plant (GCEP) program, were built in the early 1980s.

The design of the Lead Cascade complies with the Baseline Design Criteria (BDC) specified in 10 CFR 70.64(a) and the defense-in-depth requirements contained in 10 CFR 70.64(b).

The Lead Cascade facilities shown in Figure 1.1-2 (located in Appendix A of this license application) include the X-3001 Process Building (PB1), which houses up to 240 operating centrifuge machines, associated process piping, instrumentation and controls. computer systems, and auxiliary support equipment. The facilities also include the X-3012 Process Support Building (PSB) to provide oversight and control of the equipment in the cascade. The X-7726 Centrifuge Training and Test Facility (CTTF) provides areas to receive and test centrifuge components, and to assemble and repair the centrifuges. An intraplant transporter (IPT) moves centrifuge machines between the CTTF and PB1 through the covered X-7727H Transfer Corridor. The X-3012 also provides offices, lockers, change rooms, and break rooms. A portion of the X-7725 Recycle/Assembly (R/A) Building provides similar administrative facilities, as well as training rooms, and the storage and maintenance areas for the IPT.

In addition to these facilities, the Corporation also provides support facilities for the Lead Cascade. Facilities for emergency response, training, maintenance, laboratory support, utilities, environmental and waste management support, and administrative support are provided through existing facilities at PORTS. A brief description of the Lead Cascade facilities and their functions is provided below.

1.1.1.1 X-7726 Centrifuge Training and Test Facility

The CTTF contains approximately 30,000 square feet (ft^2) of floor space at ground level located in the northwest corner of the R/A Building. The CTTF is the area where material and components are received; components or subassemblies are inspected and tested; the components are assembled as centrifuge machines; the final assembly is evacuated and leak checked; and repairs are performed to the machine or subassemblies. A drawing depicting the assembly stand is provided in Figure 1.1-3 (located in Appendix B of this license application). The functional areas of the CTTF include the following:

- Machine assembly stands/repair stands
- Subassembly diagnostic/test stands
- Receipt of subassemblies, components, and materials
- Storage for centrifuges, casings, rotors, and columns
- Inspection, testing, and repair of large subassemblies
- Storage for small components and subassemblies
- Inspection and testing of components
- Assembly of subassemblies
- Functional testing of subassemblies

- Auxiliary systems area
- Electrical substation
- Backup generator

An overhead crane system traverses the length of the CTTF for movement of centrifuge machines or other large components.

1.1.1.2 X-7725 Recycle/Assembly Building

The X-7725 is a very large multiple level building. Floor areas of the R/A Building are shared with the DOE. The USEC leased portions of the R/A Building consist of a small area along the west portion of the building to allow either temporary storage or movement of completed centrifuge machines by overhead crane from the adjoining X-7726 to a ground level transporter for storage or final movement to the Lead Cascade. This area also includes a maintenance shop and battery charging area for the transporter. Administrative offices, lockers, change rooms, break rooms, and training rooms are also available in the X-7725.

1.1.1.3 X-7727H Transfer Corridor

The X-7727H Transfer Corridor provides an enclosed throughway from the X-7725 to the PB1. The corridor is an approximate 30 feet (ft) wide by 800 ft long aisle. The space is environmentally controlled and has floor to ceiling, power operated, double doors at each end to enable temperature control between facilities. Transfer corridor door actuators operate the doors between the Transfer Corridor and PB1, between the X-3002 Process Building and the PSB, and between the Transfer Corridor and the R/A Building. Two sets of doors form a barrier between the Transfer Corridor and the R/A Building to maintain the conditioned environmental controls of the R/A Building.

The surface of the transfer corridor is of concrete construction with a smooth troweled finish and is wide enough and of sufficient strength to permit two loaded transporters to pass. It is at right angles to the centrifuge aisles in PB1 and extends from the Lead Cascade process area to the CTTF. The corridor surface has expansion joints, which are perpendicular to the path of travel and are keyed together with steel to inhibit differential settlement.

1.1.1.4 X-3001 Process Building

PB1 is a high bay building housing the Lead Cascade consisting of up to 240 operating centrifuge machines. The transporter delivers assembled centrifuge machines to PB1 where a rigid mast crane removes each centrifuge machine and installs it into a cascade position. The centrifuge machine is connected to a service module position where the centrifuge is supplied with auxiliary utilities, power, controls, and UF_6 The Lead Cascade is supplied normal (approximately 0.711 wt. percent ^{235}U) UF_6 from either a Model 5A/B, 8A, or 12B UF_6 cylinder through a feed system consisting of a portable cart capable of heating the solid material to a gaseous state. After the initial fill from the portable feed cart, the centrifuge machines operate on a recycle mode as a "closed loop" system in the gaseous state, and the feed cart is on "standby." This recycle mode in the "closed loop" causes the enriched material within the cascade to be mixed with the depleted material within the cascade prior to it re-entering the feed stage. Laboratory quantities of UF_6 are sampled from the Lead Cascade in order to perform analyses. No enriched product is withdrawn from the cascade, except for the samples. Samples are processed in the X-710 Analytical Laboratory. The cascade enrichment is normally less than 5 wt. percent assay. However, testing of the cascade may result in some material being enriched above 5 wt. percent, with a licensed limit of 10 wt. percent ^{235}U.

A dump cart is provided to remove the contents of the cascade in the event inventory must be reduced for normal operations or as a result of upset conditions. A local control center (LCC) at the cascade provides operator interface through controls and instruments with the centrifuge machines, and an area control room (ACR) located in the X-3012 also provides limited control of the centrifuges remotely.

The north end of PB1 has an equipment/utility mezzanine where auxiliary equipment is housed. Items in this area consist of heating and ventilating equipment, cooling water pumps, vacuum pumps, and electrical switchgear. A building vent for the purge and evacuation vacuum systems is also located in PB1. Due to the nature of centrifuge operation, a purge vacuum is applied to the machine to remove any gas (either process gas or in-leakage of atmospheric gases) that enters the space between the internal rotor and the casing. The vent is monitored and is permitted through the Ohio Environmental Protection Agency (EPA).

1.1.1.5 X-3012 Process Support Building

The PSB is located east of PB1. The PSB houses the ACR, maintenance shops and stores, offices, men's and women's lockers and restrooms, and a lunchroom. A high bay (60 ft clear height) transfer corridor divides the PSB between the operations and maintenance functions.

1.1.1.6 Support Facilities

In addition to the primary facilities described above, several other PORTS facilities provide support and/or services for the Lead Cascade. Utilities provided to the Lead Cascade include electrical, sanitary water, sanitary sewer, instrument air, communications, and non-potable cooling water. Also, emergency response, training, maintenance, laboratory, environmental management, and administrative support are provided through existing facilities and services at PORTS. Two of the principal support facilities are discussed below.

1.1.1.6.1 XT-847 Waste Management Staging Facility

The XT-847 Waste Management Staging Facility is located near the southern end of the PORTS reservation. The building is a steel structure with concrete floors and is divided into three major staging areas. The northern and southern sections are separated from the center section of the building by concrete block four-hour rated firewalls and steel fire doors. An administrative area adjoins the staging area.

The facility is used to accumulate and stage/prepare radioactive waste and non-hazardous recyclable materials prior to shipment off-site. The building is equipped with truck and rail loading/unloading facilities and scales.

1.1.1.6.2 X-710 Technical Services Building

The X-710 Technical Services Building Analytical Laboratory performs chemical and isotopic analyses for the Lead Cascade.

Included in these services are sample specification analyses, enrichment performance analyses, Nuclear Criticality Safety limitation analyses, uranium accountability analyses, and mass spectrometry isotopic analysis; vent emission analyses; and High Efficiency Particulate Air filter testing. The laboratory routinely performs inorganic, organic, asbestos and radiochemistry analyses and physical properties measurements of samples in support of various programs and facility operations. Further, the laboratory provides technical support for non-destructive analysis of equipment and materials.

1.1.2 Process Description

This process description is broken into five sections that describe the primary gas centrifuge process: 1) general separation fundamentals, 2) centrifuge separation fundamentals, cascade theory, 4) design of the gas centrifuge, and 5) operation of the gas centrifuge.

Other operations that are performed to support the primary process include equipment and machinery repair and fabrication of specialized equipment. These activities may be conducted with equipment contaminated with uranium-bearing material. The uranium-bearing material could be UF_6, uranium tetrafluoride (UF_4), uranyl fluoride (UO_2F_2), or an intermediate oxy-fluoride.

1.1.2.1 General Separation Fundamentals

The processing of UF_6 into an isotopic content that enables most commercial nuclear reactors to produce electricity through a controlled fission reaction is called enrichment. The enrichment process increases the concentration of the fissionable ^{235}U isotope from its naturally occurring assay of approximately 0.711 wt. percent to a range of 2 to 5 wt. percent assay. The balance of uranium consists primarily of the ^{238}U isotope.

There are two methodologies of enrichment commercially employed, the gaseous diffusion process and the gas centrifuge process. Both processes consist of the interconnection of multiple "separation elements" in configurations known as a cascade. Figure 1.1-4 is a diagram of a separation element, consisting of a feed stream (F) that is separated into product (P) and tails (T) streams. The concentrations of ^{235}U in the feed, product and tails streams are N_F, N_P and N_T, respectively.

The amount of effort required to increase (enrich) a given quantity of uranium from concentration N_F to concentration N_P is described in terms of separative work units (SWU). Separative work is a descriptive mathematical quantity that encompasses the separation factor, ability of a separation element to separate ^{235}U and ^{238}U, and the material flow of a separation element.

1.1.2.2 Centrifuge Separation Fundamentals

Figure 1.1-5 shows a simplified schematic of a gas centrifuge machine. A centrifuge machine consists of a large rotating cylinder and piping for the feeding of UF_6 gas and the withdrawal of depleted and enriched UF_6 gas streams. The rotating cylinder, called the rotor, is contained within another cylinder, called the casing, which maintains the rotor in a vacuum and provides physical containment of components in the unlikely event of a catastrophic failure of the machine. Other major components of a centrifuge include upper and lower suspension systems and a motor and control system.

For an operating centrifuge, UF_6 gas is fed into the rotor, which is spinning at relatively high rotational velocities. The heavier $^{238}UF_6$ isotope accumulates at the rotor wall, whereas the lighter $^{235}UF_6$ isotope accumulates more toward the center (pushed away from the wall by the $^{238}UF_6$ isotopes). A slight axial (counter current) flow, induced by mechanical and/or thermal agitation, carries the $^{238}UF_6$ downward along the wall and the $^{235}UF_6$ upward along the axis. As the gas travels up the axis of the centrifuge, it is constantly being depleted in $^{238}UF_6$ and enriched in $^{235}UF_6$. So the longer the centrifuge and the faster gas can be transported from one end of the centrifuge to the other, the higher the centrifuge machine's separative capacity will be. The combined effect of the radial gradient and axial flow enables a relatively significant assay gradient to develop between the bottom and the top of the centrifuge.

The separation capacity of a centrifuge is the function of two phenomena: one, the radial separation, and two, the axial separation. Radial separation (separation factor) is created by centrifugal force. Axial separation is created by the net transport of $^{235}UF_6$ to the top and $^{238}UF_6$ to the bottom of the centrifuge. The separation factor of the centrifuge process is an order of magnitude higher than that of the gaseous diffusion process, although neither is much greater than a factor of one. Due to the higher separation factor of the centrifuge process, there are also orders of magnitude fewer stages required in a centrifuge facility than in a gaseous diffusion plant (GDP).

1.1.2.3 Cascade Theory

Separating elements are connected in series, called stages, to achieve the desired assay of ^{235}U. Many separating elements are also connected in parallel in the centrifuge process to achieve the desired mass flows, forming a cascade. Figure 1.1-6 shows a schematic of a typical cascade that takes on a "diamond" shape. Natural feed enters the cascade at the middle of the diamond, with product streams being enriched in ^{235}U to the top of the diamond and the tails streams being depleted of ^{235}U to the bottom of the diamond. There are nine stages in the example cascade shown, including a feed stage, five enrichment stages and three stripping (depletion) stages.

1.1.2.4 Design of the Gas Centrifuge

The gas centrifuge machine is comprised of a number of subassemblies (see Figure 1.1-5):

- Casing
- Rotor
- Column
- Upper Suspension Assembly (USA)
- Lower Suspension and Drive Assembly (LSDA)
- Diffusion Pump (not depicted in figure)

Degradation or failure of any of these key components can have a significant impact on the operation of the centrifuge machine. The most significant failures that can occur involve the rotor, and the upper and lower suspension assemblies. Complete failure of any of these components that cause a failure of the rotor is called a "crash" and requires removal, replacement, or isolation of the entire machine. On the other hand, failure of the other components, such as the thermal shield, is more likely to cause degradation in the performance of a machine, but is not expected to lead to a machine crash.

1.1.2.4.1 Casing

The casing is the outermost cylinder of a centrifuge and serves several functions. Foremost, the casing acts as a means of containment of rotor debris in the unlikely event of an internal failure, protecting personnel and adjacent machines from harm. The casing is also a vacuum chamber for the rotor. It is important to maintain the outside of the rotor in vacuum because any gas that impacts the rotor's exterior wall causes drag, which in turn causes localized heating of the rotor and consumes power from the motor, thereby slowing it down. The casing also acts as a structural support for the rotor, the upper suspension, and column assemblies.

1.1.2.4.2 Rotor

The rotor in a centrifuge consists of a thin walled rotating shell with end caps on both ends. The rotor is designed to contain process gas while spinning at relatively high peripheral velocities enabling the enrichment of the desired isotope. A number of factors are taken into account when designing a rotor such as materials of construction and speed of operation. Rotors are often made of light, high strength-to-weight ratio materials, such as carbon fiber reinforced plastics.

In choosing the material of construction for the rotor, several characteristics are of importance:

- Ultimate tensile stress
- Modulus of elasticity
- Density
- Resistance to corrosive attack by UF_6

The ultimate tensile strength of the material determines the maximum peripheral velocity a rotor can survive before bursting. As the ultimate tensile strength increases and the density decreases, the maximum operational velocity of the rotor and therefore, SWU output increases.

The rotor geometry, length and radius, and the material of construction's modulus of elasticity and density determine the critical frequencies of the rotor. A critical frequency occurs when the natural resonating frequency and the rotational frequency of the rotor coincide. When a critical frequency is reached the rotor starts to vibrate like a plucked guitar string. These vibrations cause off-normal stresses in the suspension system that can lead to failure.

A rotor can have multiple critical frequencies, with each increasing frequency resulting in a greater number of nodes. In general, a centrifuge is called a subcritical or a supercritical machine, if it is operating below or above its first critical frequency, respectively.

The rotor material's ability to resist corrosion is crucial to the operational life of a centrifuge. A rotor that does not have corrosion resistance to the process gas will experience degradation of the very mechanical properties that allow it to operate.

1.1.2.4.3 Column

The process piping internal to the centrifuge machine is called the column. The column provides a means to introduce UF_6 gas (feed) into the machine while removing enriched UF_6 gas (product) and depleted UF_6 gas (tails). When designing the column, care is taken to keep the structure as rigid as possible, thereby maintaining machine alignment and tolerances within operating limits. As a result of the opening created by the column passing into the rotor, some lighter gases are free to enter the space between the rotor and the casing where it is removed by the diffusion pump.

1.1.2.4.4 Upper Suspension Assembly

The USA consists of a magnet that carries a fixed percentage of the rotor weight and is designed to compensate for changes in the length of the rotor as it is driven to speed.

1.1.2.4.5 Lower Suspension and Drive Assembly

The LSDAs use a motor and a suspension system to drive and support the rotor, respectively. The management of heat within the lower suspension and drive assembly is important to maintaining a controlled thermal gradient within the rotor.

1.1.2.4.6 Diffusion Pump

The diffusion pump maintains the casing vacuum by continually removing any gas, either process gas or in-leakage of atmospheric gasses, that enters the space between the rotor and the casing. As previously described, it is important to keep gas molecules from impacting the outside of the rotor.

1.1.2.5 Operation of the Gas Centrifuge

The arrangements of the centrifuges in the UF_6 enrichment process are selected to minimize the likelihood of a major interruption of operations. This design concept favors the use of small, separate, systems such that individual centrifuges or entire cascades can be isolated to minimize losses due to abnormal operating circumstances. A primary purpose of isolation is to prevent or limit the transport of light gases to centrifuges that are operating satisfactorily. Light gases can be introduced from leaks, misoperation of the UF_6 feed system, and centrifuges that are encountering operational problems.

1.1.2.5.1 Service Module

Within the process building, utilities and process piping are routed to the centrifuge machines via service modules that consist of a welded, square-tube steel frame structure with pipe headers and valves, control and instrument cabling, ventilation ductwork, and electrical distribution cables running the full length. Pipe headers for process gas, vacuum, and air are aluminum, while those for cooling water and fire suppression are steel. Smaller branch pipes connect the headers to each of the centrifuge machines. The machine isolation valves (MIVs), machine power controls, and machine instrumentation are also mounted on the service modules. Each service module services twenty centrifuge machines and the service modules are connected in series to support an operating cascade.

1.1.2.5.2 Intermachine Flow and Control

The intermachine flow and control system consists of:

- The process piping headers and valves for transporting the process gas;
- The feed control system for controlling the cascade feed rate;
- The inventory control system for maintaining the proper tails backpressure on each machine;

- Instrumentation and controls for header pressures and centrifuge machine status; and

- The sampling system for measuring product and tails assays and product contaminants.

1.1.2.5.3 Process Piping Headers and Valves

Centrifuges for the cascade are arranged in a series of stages. Figure 1.1-7 shows a multi-stage configuration and the flow arrangement between stages. Isolation valves for the individual centrifuge are contained in a MIV set that takes valve mode commands from a machine variables instrument package (MVIP). The Lead Cascade is operated in the cascade recycle mode and the feed/total cascade recycle header receives flows from the cascade tails (depleted material) and product (enriched material) headers. The source for the initial feed is a feed cart and withdrawal from the tails or product headers is performed with a sample cart for the purpose of obtaining sample quantities for laboratory analysis. Figure 1.1-8 (located in Appendix B of this license application) depicts the Lead Cascade system interfaces.

1.1.2.5.4 Feed Control System and Dump System

The feed system for the Lead Cascade is a portable cart (Figure 1.1-9) designed to heat, if required, a cylinder of solid normal UF_6 to vaporize the solid for feeding. Prior to feeding UF_6 from the feed cylinder to the centrifuge machines, the cylinder may be burped to remove contaminants (lights) that would impact the operation of the machine. This is accomplished utilizing the dump cart (Figure 1.1-10) or purge vacuum system. The UF_6 is fed to the cascade, and the Lead Cascade is operated in the recycle mode after the initial fill. The feed cart is placed on standby. In the event of an operational upset or other condition requiring removal of inventory, a dump cart is connected to the cascade during recycle operations to implement removal of the UF_6 from the cascade. The dump cart cylinder contains depleted UF_6.

1.1.2.5.5 Inventory Control System

Regulating the tails header pressure in each stage controls the cascade inventory. This method permits control of the tails flow from each stage and minimizes inventory changes in the centrifuges. The inventory control system consists of a backpressure control valve (BPCV) and a reference pressure (datum) line to remotely adjust the setpoint of the BPCV. Datum pressure controls and monitoring capabilities of the control valve position are provided at the LCC and the ACR.

1.1.2.5.6 Instrumentation and Controls

Consistent with operation of an industrial facility, the LCC provides the operator interface through keyboard and pushbutton controls, status indicators, annunciators, analog and digital displays, and pneumatic pressure regulators. Cascade feed, product, and tails pressures are monitored, displayed and alarmed in the LCC and ACR. Valve control commands are provided and the valve positions are monitored and alarmed in the LCC and ACR. Centrifuge isolate/un-isolate and dump commands, speed controls, and centrifuge status are provided remotely in the LCC and ACR. Automatic controls and programmed software protect equipment in the event of abnormal operations.

The feed and tails pressures of each stage are monitored. Temperature sensors/transmitters are located at different positions on the outside casing of several machines and along the service module. The temperatures and pressures are displayed and alarmed as required at the LCC and ACR.

Some centrifuge casings are equipped with a flange for mounting a pressure sensor and interface connectors for monitoring other machine parameters. These measurements are displayed on a portable readout device.

1.1.2.5.7 Sampling System

A sample cart (Figure 1.1-11) is provided to withdraw process gas samples for laboratory analysis to confirm the enrichment process. No enriched material is withdrawn, other than laboratory samples. In addition, contaminants in form of light gases (e.g., oxygen, nitrogen, and carbon dioxide) are monitored by taking grab samples from sample taps on the product and tails headers of each stage.

1.1.2.6 Machine Assembly

The centrifuge machines for the Lead Cascade are assembled in the CTTF. Parts for Lead Cascade centrifuge machine assembly are received at this location. Secure facilities are available to receive and store the classified parts as well as other components of the centrifuge machines. Additional parts receiving and storage space is available if necessary in the adjacent R/A Building. Overhead cranes, fork trucks, and a parts elevator are available to handle timely parts delivery to the CTTF assembly stand for assembly.

Two machine assembly positions and a column assembly stand are provided in the CTTF assembly stand for assembly of the various components into a completed machine. Overhead cranes are available for material handling needs including long parts insertion and lower and upper assembly installation. Lifting fixtures and other assembly tooling are also required during the assembly of the Lead Cascade machines. Gross leak testing is performed at this location before the assembled machine is moved from the CTTF assembly stand. No process gas (UF_6) testing of the machines take place in the CTTF. Completed machines may be moved via crane to an adjacent storage location until they can be moved, again by crane or moved directly, to a transporter for movement to the process building. Testing of the machines using UF_6 is performed in PB1 after installation, prior to being placed into service.

1.1.2.7 Lead Cascade Support Systems

After assembly of the machine, several additional systems are provided to move the completed machine to its proper location and for connection and checkout prior to start-up.

1.1.2.7.1 Purge Vacuum/Evacuation Vacuum

The high peripheral velocity of a gas centrifuge requires the rotor to operate in a high vacuum to minimize friction. Each centrifuge casing is therefore fitted with a diffusion pump to produce the required vacuum between the rotor and the casing. The purge vacuum (PV) system for the Lead Cascade maintains a suitably low pressure for efficient operation of the diffusion pumps during normal operation. The output of the diffusion pumps discharges to the PV system. Any UF_6 and light gases that may escape from the rotor and any light gases entering the vacuum system due to in-leakage are removed.

Each PV system includes two mechanical vacuum pumps each equipped with automatic valves, power, and controls to enable one vacuum pump to serve as a spare for the other. The PV system also includes the piping network necessary to accommodate the flow of the effluent gases as they pass from the centrifuge diffusion pump to the atmospheric vent. Two banks of four chemical traps, one on-line and one stand-by, and an exhaust gas analyzer with UF_6 and gas flow monitoring capability are provided as part of the system. One or two PV systems are utilized depending on the number of installed machines.

The main sources of gases to be removed from the centrifuge by the PV system are:

- Air leakage into the casing, process lines, or PV system;
- Hydrogen fluoride that originates from the cascade feed and from the reaction of UF_6 and moisture from air in-leakage;
- UF_6 leakage into the centrifuge casing vacuum; and
- Residual inert gas from UF_6 feed cylinders.

The evacuation vacuum (EV) system, which interfaces with the PV system at the diffusion pump and at the chemical traps, shares with the PV system the chemical traps, the exhaust gas analyzer, and the building vent piping to the outside environment. The PV and EV systems are shown on Figure 1.1-12. A manual interlock prevents the centrifuge from being valved into the EV system and PV system at the same time.

The purpose of the EV system is to reduce the casing pressure of newly installed or replacement centrifuge machines from atmospheric pressure down to a sufficiently low value so that the centrifuge casing can be connected to the PV system without upsetting PV system operation. The EV system also evacuates the service module process headers.

The EV system includes two mechanical vacuum pumps, valves and controls to permit one vacuum pump to serve as a spare for the other. The system also includes the piping network required to connect the centrifuges from the diffusion pump through the service module piping to the mechanical vacuum pumps, and piping from the discharge of the mechanical vacuum pumps to the chemical traps that are also part of the PV system.

Gases vented by the PV and EV systems are monitored to ensure proper operation of chemical traps to minimize any potential release of radionuclides. The EV system has the capability to bypass the chemical traps during initial start-up and to pump down service modules, piping, and new machines prior to gas introduction.

1.1.2.7.2 Machine Cooling Water System

The machine cooling water (MCW) system, shown in Figure 1.1-13, is a closed-loop circulating water system designed to provide cooling of the centrifuge diffusion pump, LSDA, and the PV and EV vacuum pumps.

The MCW system serves the Lead Cascade and associated mechanical vacuum pumps. This system contains circulating water pumps, filter, heat exchanger, an expansion tank, and a piping tie-in to the chemical feed, deionizer, and sanitary water systems.

Heated MCW leaves the centrifuge cascade through the service module header to an expansion tank, which provides enough suction head for the MCW circulating pumps. The tank provides a convenient point for adding make-up water and the water treatment chemicals. The discharge of the circulating pumps passes through a MCW filter to a heat exchanger. The heat exchanger cooling water is supplied from the site cooling tower, where the MCW is cooled. The cooled MCW then returns to the centrifuge machines by way of the supply header in the service module.

The MCW system requires a chemical feed system where water treatment chemicals are added. The chemical feed system contains a chemical tank from which chemicals are added via a chemical injection pump.

Sanitary water is provided for MCW makeup water. This water passes through a deionizer before entering the MCW closed loop. The makeup water is used for initial fill purposes and for maintaining the proper level of MCW in the system. MCW system alarms are monitored in the ACR.

1.1.2.7.3 Machine Mount System

The machine mount system is the primary structural interface between the soil subgrade of the PB1 floor and the centrifuge machines. The machine mount system is a hard-torsion, hard-shear, and soft-rocking system consisting of two groups. The floor module group contains the frame and the reinforced concrete. The machine-mounting group contains the isolation subsystem and the support subsystem.

The mount system is designed so that each machine responds to its operating environment independently of all other machines. This is accomplished by having a stiff, massive concrete and steel-reinforced mat that mitigates the effects of torque and shear forces experienced during rotor failures (operational upset). The overturning forces experienced during rotor failure are mitigated by the machine mount system's soft-rocking suspension. This soft-rocking suspension system also attenuates the vibration response from external excitation such as an earthquake. Elastomeric isolators are arranged in a symmetrical pattern about the fifth point support to provide a uniform response to a possible random direction of applied ground motion loads.

1.1.2.7.4 Machine Transport System

The machine transport system, consisting of the intraplant tow tractor (IPTT), IPT, and rigid mast crane, installs and removes centrifuges in the Lead Cascade and transports them along the transfer corridor between the Lead Cascade in PB1 and the CTTF. Movement between the CTTF and PB1 is accomplished with the IPT and the IPTT. Movement between the IPT and the operating position in PB1 is accomplished with a rigid mast crane.

The IPT is a wheeled trailer with a hitch and steering linkage located at both ends of the unit. An operator's station is provided on the IPT for control of the leveling and stabilizing systems. The IPT is equipped with clamping mechanisms to secure each centrifuge in a vertical position during the IPT's modes of operation. The IPTT provides the motive force for the IPT.

The rigid mast crane consists of a 7 ½-ton capacity, electric-powered, top-running, double-girder, overhead bridge that carries a top-running trolley. The trolley incorporates a rotating platform, which is mounted on a large-diameter bearing near the center of the trolley to provide 370° rotation. The rotating platform supports hoist machinery, a vertical rigid mast, and the operating cab. The hoist raises and lowers a load carriage, which travels along mechanical guides on the rigid mast. The rigid mast serves to prevent the load from swinging during movement of the rigid mast crane. An upper load-lifting yoke and a load-stabilizing clamp are provided on the load carriage to lift and hold a centrifuge. The rigid mast crane is controlled in both the manual and programmed positioning mode by the operator in the crane cab, or during precise positioning operations, by an operator at floor level using a hand-held, reel-mounted pendant control. The pendant control contains a direct communication line between the cab operator and the floor operator.

1.1.2.7.5 Heating, Ventilation, and Air Conditioning

The Lead Cascade heating and ventilation systems are designed to maintain the environment required for proper operation of the process and associated equipment in the process buildings. The main subsystems affecting X-3001 are the Process Area Ventilation System and the Process Area Heating and Pressurization System.

The Process Area Ventilation System provides circulation of air and maintains a positive pressure with respect to the outside ambient atmospheric pressure in X-3001 to reduce the infiltration of dirty and/or cold air. Each ventilation unit consists of a supply fan, a return/exhaust fan, filters, and associated ductwork with automatic dampers, and controls. The return/exhaust air fan draws heated air from the centrifuge machine area and, depending on the building temperature, exhausts it to the outside or recirculates it to the supply fan plenum. If it is necessary to cool the process building, outside air is drawn through a damper into the supply fan plenum where it mixes with air from the return/exhaust fan and passes through a filter to the supply fan inlet. The supply fan discharges through a damper into a large duct located along the length of the cascade on top of the service module piping. Tempered air is directed from the service module duct outward to the centrifuges. No heating coils are provided in this system. The Process Area Ventilation System can also be used for smoke removal in the event of a fire in the X-3001.

The Process Area Heating and Pressurization System heats the outside make-up air to building temperature and supplies enough heat to offset exterior wall and roof heat losses. Individual heating and pressurization units are located on the mezzanine in X-3001. Each unit consists of a pneumatically operated outside air intake damper, a return air damper, a filter section, a heating coil section, a supply fan, and distribution ducts. The outside air and return air dampers are modulated to maintain a positive building pressure. Recirculating Heating Water (RHW) supplied from the DOE RHW Boiler System is supplied to the heating coils.

Heating, ventilation, and air conditioning (HVAC) are provided to the X-3012 to provide proper operation of the equipment, as well as comfortable working conditions for Lead Cascade personnel. Other areas of the Lead Cascade are provided with HVAC or only heating and ventilation, depending on location and function of the area.

1.1.2.8 Plant Support Systems

In addition to the Lead Cascade support systems described above, the two primary utility support systems provided through existing GDP support systems are electrical supply and instrument air.

1.1.2.8.1 Main and Auxiliary Power System

The Lead Cascade obtains its electrical power from the same complex of incoming high-voltage transmission lines as the GDP via the X-530 Switchyard, but utilizes a separate set of step-down transformers to supply all the electrical power requirements for the Lead Cascade facilities via 15 kilovolt (kV) feeders from the X-5001 Substation. Each power transformer is sized to carry the complete load of the respective substation. The switchgear is arranged so that all feeders can be fed from any transformer in the respective substation.

The Lead Cascade 15 kV power distribution system shown in Figure 1.1-14 is a "radial" system (i.e., no paralleled source of power). Essential loads in the Lead Cascade are supplied from double-ended substations in which a bus-tie breaker can be closed when power is lost to one end of the substation and portions of which are further supported with standby power such as engine-generators.

1.1.2.8.2 Instrument Air System

The Instrument Air (YA) system provides dry, oil-free compressed air for the operation of pneumatic control isolation valves, instrument consoles, backfilling of machines, and other air needs at a nominal pressure of 100-110 pounds per square inch gauge (psig). The compressed air contains less than 0.05 parts per million (ppm) oil, with a maximum moisture content equal to or better than a 0° Fahrenheit (F) dew point at atmospheric pressure, and contains no particulate greater than 10 microns.

YA for the Lead Cascade is supplied through a header in the service module to the centrifuge machines. YA is also required by the PV, EV and environmental control systems, and is used in the CTTF.

1.1.3 Hazardous Materials Storage

Large quantities of hazardous materials are not present in the Lead Cascade area. Only small quantities of chemicals and materials (e.g., acetone, solvents, oils) are used in the X-7726 and X-3012 buildings, primarily for assembly and maintenance activities. Storage of the chemicals and materials is in approved containers. Those items are listed in the Hazardous Material Inventory Control System. These materials are appropriately reported annually to the Federal and State EPA as required by the *Superfund Amendments Reauthorization Act* (SARA Sections 312 and 313 reports).

USEC complies with all requirements for generators of hazardous and mixed waste. The State of Ohio has adopted a federal exemption[1] to the hazardous waste rules that is available under 40 CFR Part 266 Subpart N.

1.1.4 Roadways and Railroads

The PORTS reservation is serviced by two major four lane highways: U.S. Route 23, traversing north-south, and State Route 32/124, traversing east-west. PORTS is situated approximately three and one half miles from the intersection of U.S. Route 23 and State Route 32/124. Ingress and egress from the reservation to these major roadways is by the Main Access Road, which connects to U.S. Route 23. The Main Access Road connects to the Perimeter Road, which encircles the PORTS reservation. Service roads throughout the reservation connect to Perimeter Road with access to the facility controlled through security portals. The reservation roadways are depicted in Figure 1.1-1.

The Norfolk Southern rail line is connected to the CSX Transportation Inc. main rail system by a rail spur entering the northern portion of the reservation. The CSX Transportation Inc. system also provides access to other rail carriers. Several track configurations are possible within the site. The Lead Cascade is also connected to the existing rail configuration. The railroads are also depicted in Figure 1.1-1.

1.1.5 Site Boundary

PORTS is located approximately one and one half miles east of U.S. Route 23 on approximately 3,708 acres of DOE-owned land. The area around the site is sparsely populated,

[1] At the time of submission of this license application, the State of Ohio was in the process of adopting a federal exemption to the hazardous waste rules that is available under 40 CFR Part 266 Subpart N. This exemption would delegate the Federal EPA's authority over mixed waste to the NRC, subject to certain conditions. The State of Ohio can adopt this exemption by amending the Ohio EPA regulations to adopt the federal exemption by reference.

with the nearest residential center located approximately four miles to the north. The Lead Cascade facilities are located in the western portion of the reservation. Proximity to the nearest member of the public is about 900 meters (m).

This figure is withheld pursuant to 10 CFR 2.790 and is located in Appendix A of this license application

Figure 1.1-1
PORTS Reservation

This figure is withheld pursuant to 10 CFR 2.790 and is located in Appendix A of this license application

Figure 1.1-2
Lead Cascade Facility Layout

This information within this figure has been determined to contain Export Control Information and is located in Appendix B of this license application

Figure 1.1-3
CTTF Assembly Stand

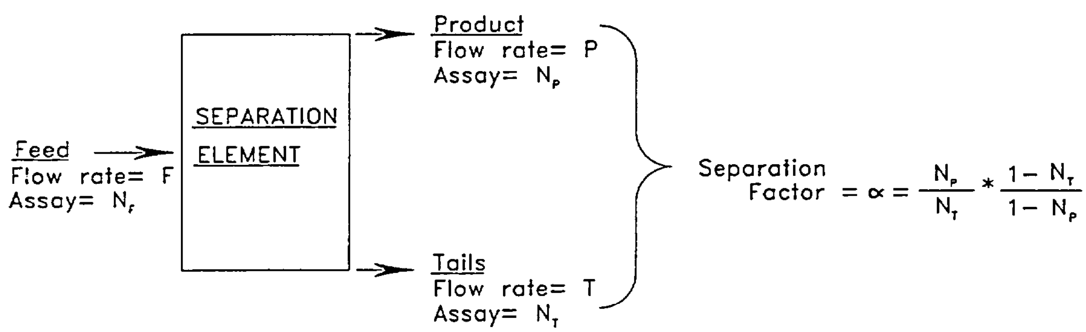

Figure 1.1-4
Separation Element

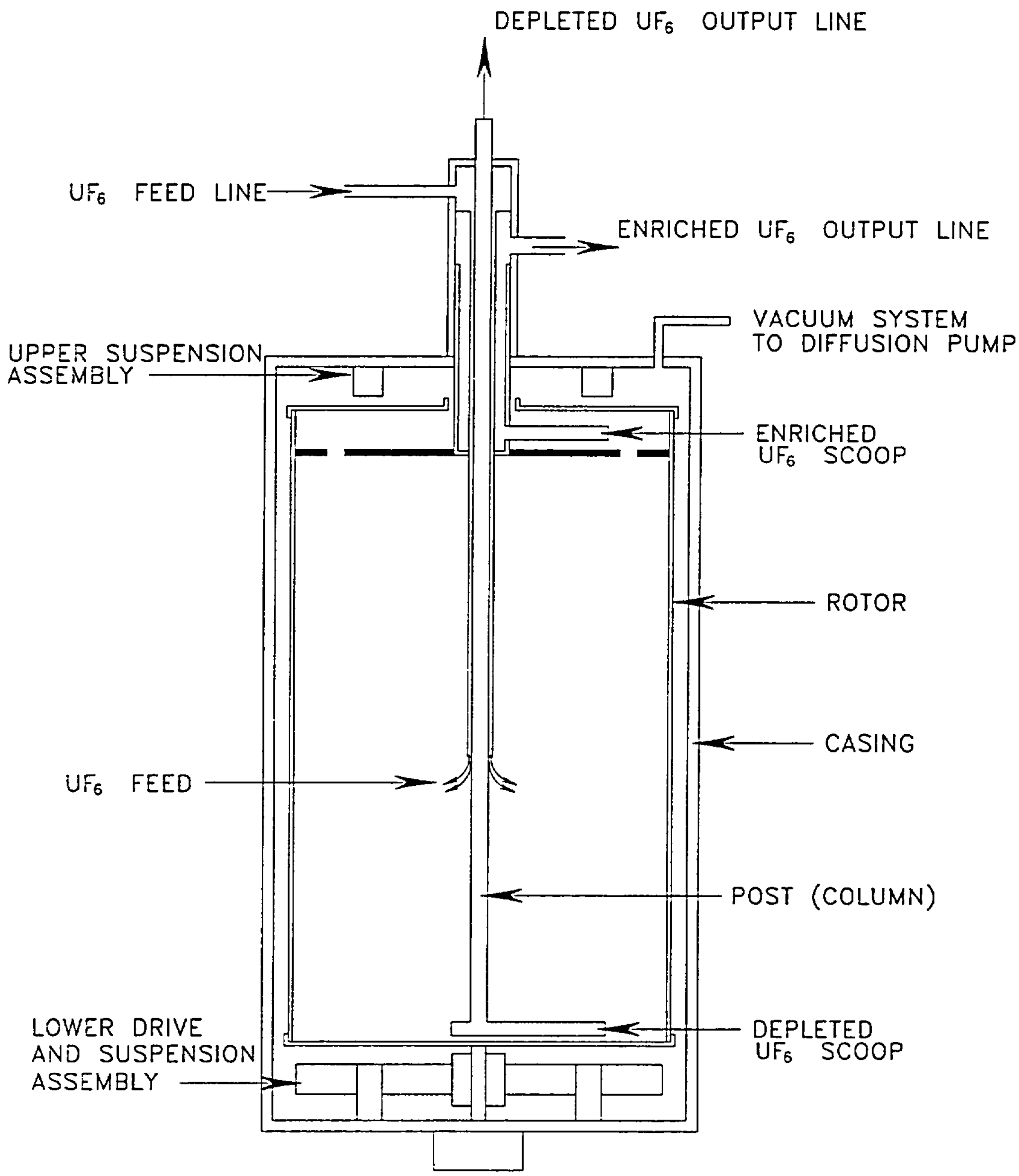

Figure 1.1-5
Centrifuge Schematic

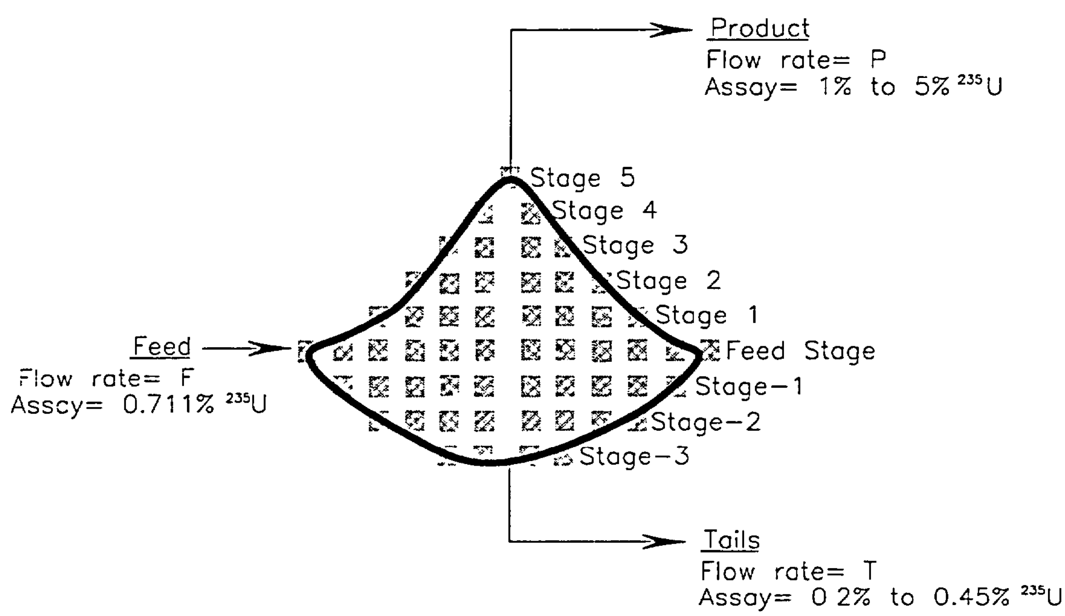

Figure 1.1-6
Example Cascade Schematic

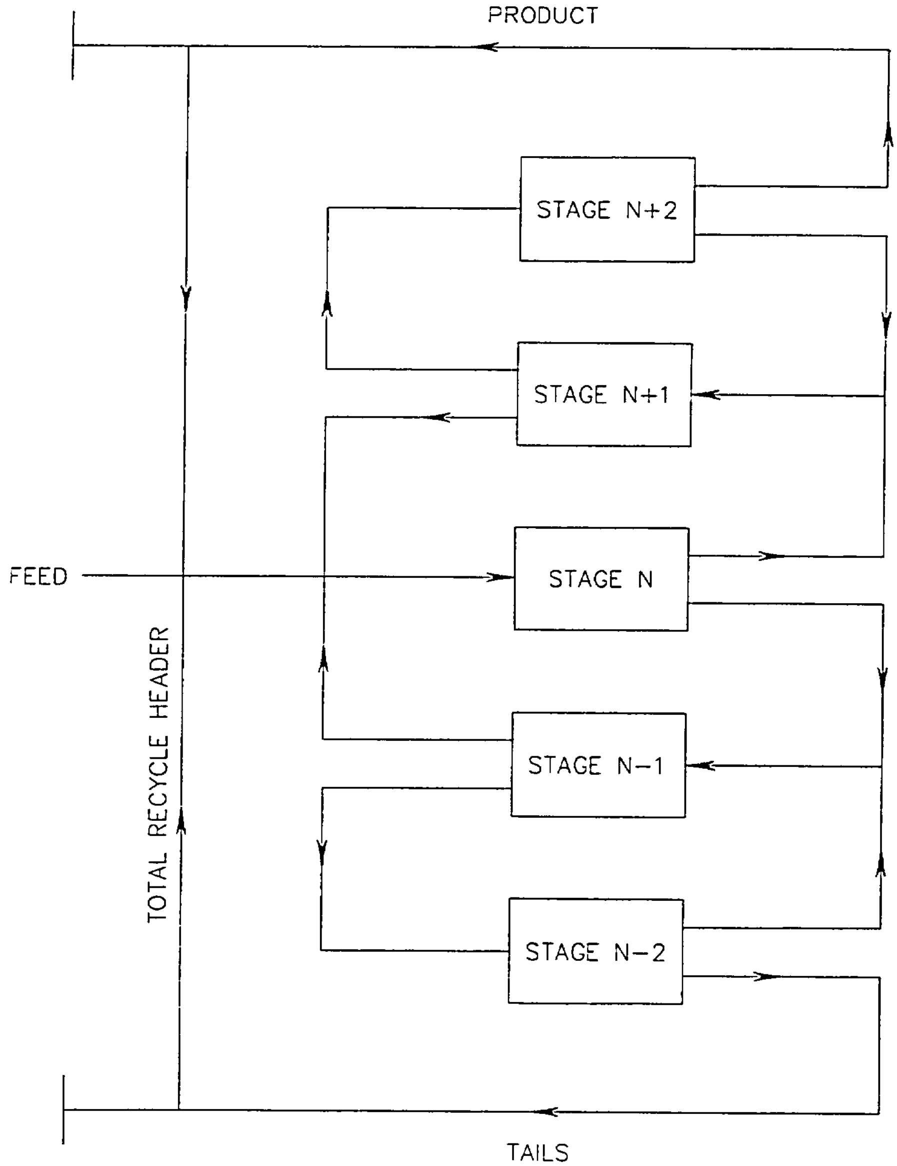

Figure 1.1-7
Example Cascade and Stage Flow Schematic

This information within this figure has been determined to contain Export Control Information and is located in Appendix B of this license application

Figure 1.1-8
Lead Cascade Systems Interfaces

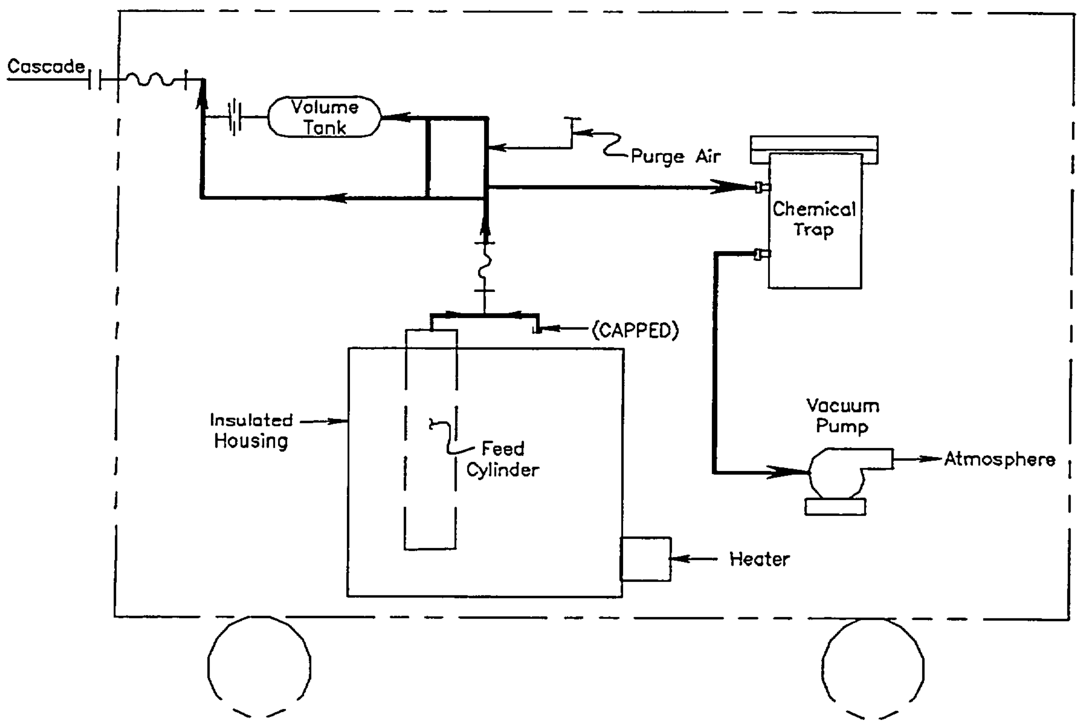

Figure 1.1-9
Feed Cart Flow Diagram

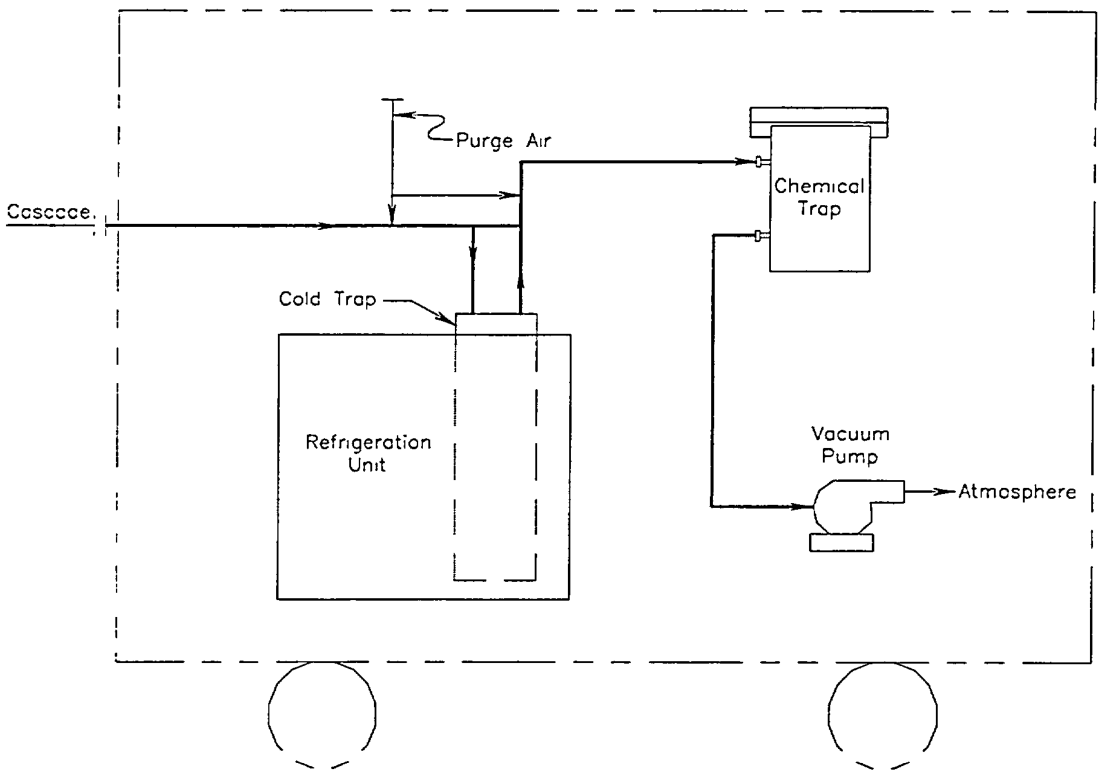

Figure 1.1-10
Dump Cart Flow Diagram

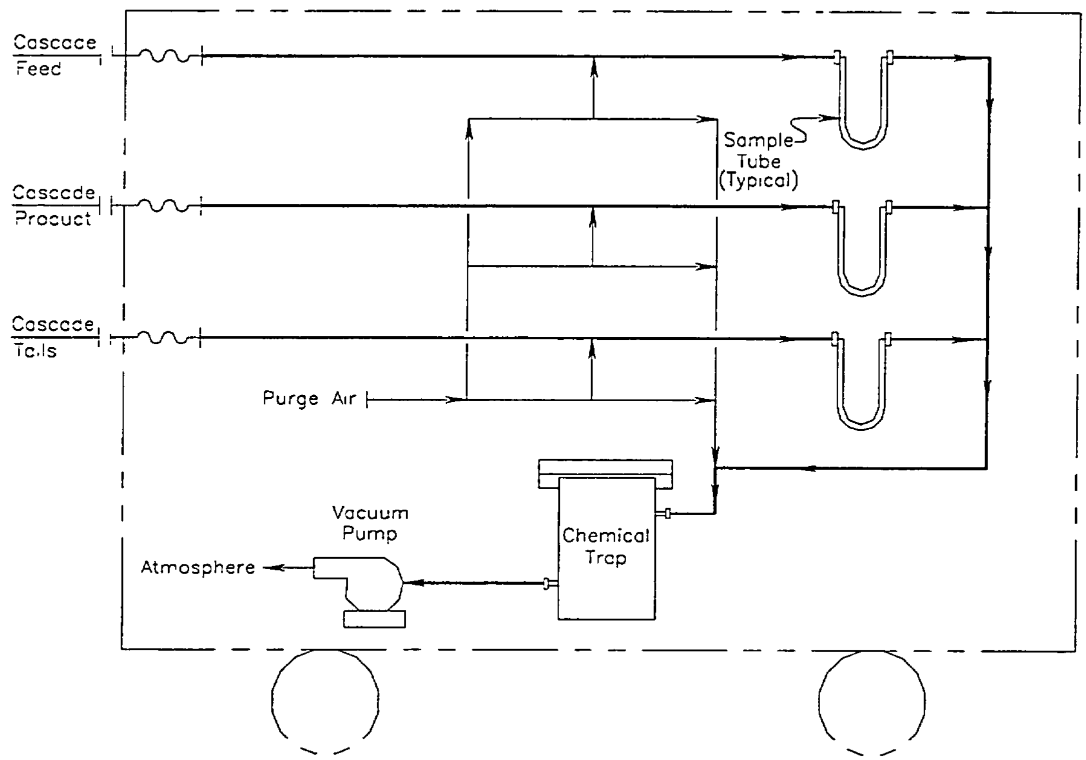

Figure 1.1-11
Sample Cart Flow Diagram

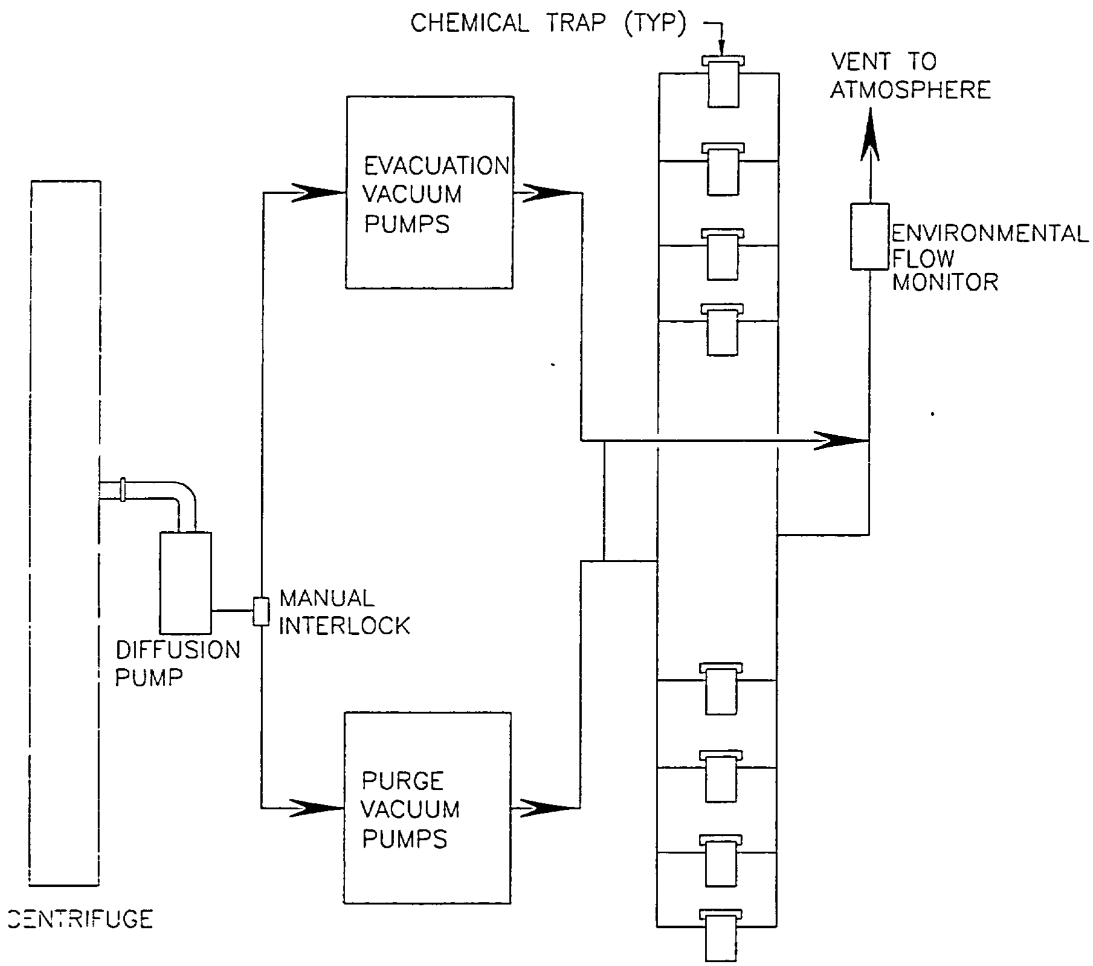

Figure 1.1-12
Purge Vacuum and Evacuation Vacuum System Schematic

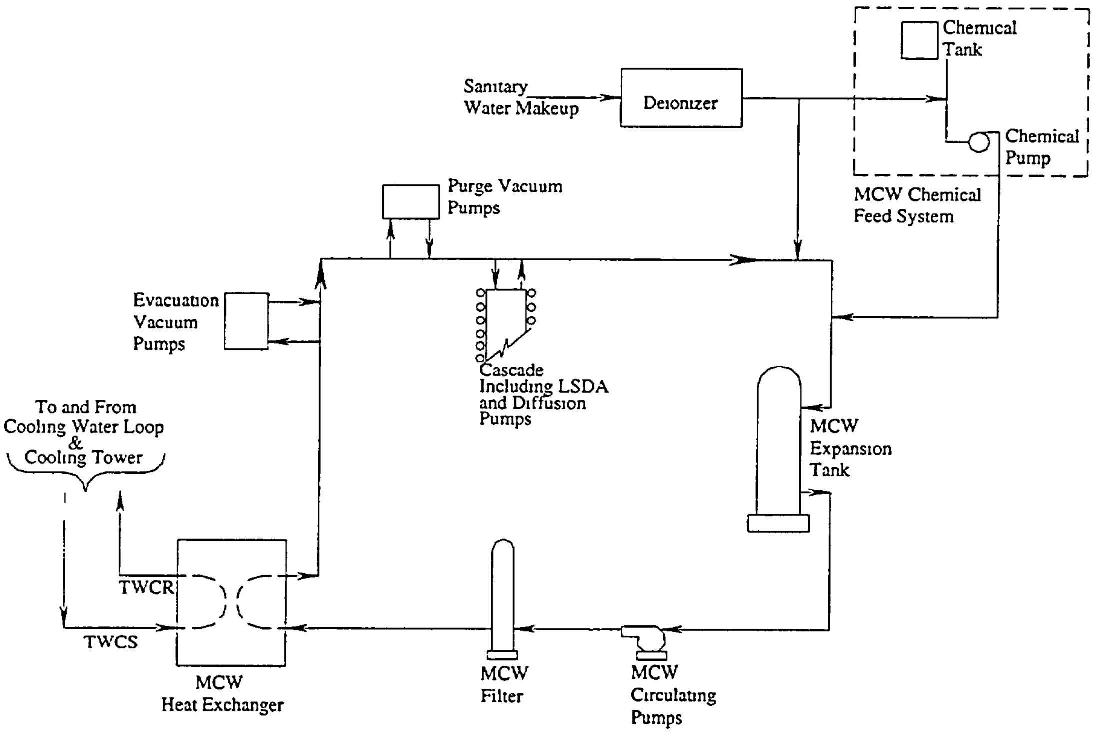

Figure 1.1-13
Machine Cooling Water System Flow Schematic

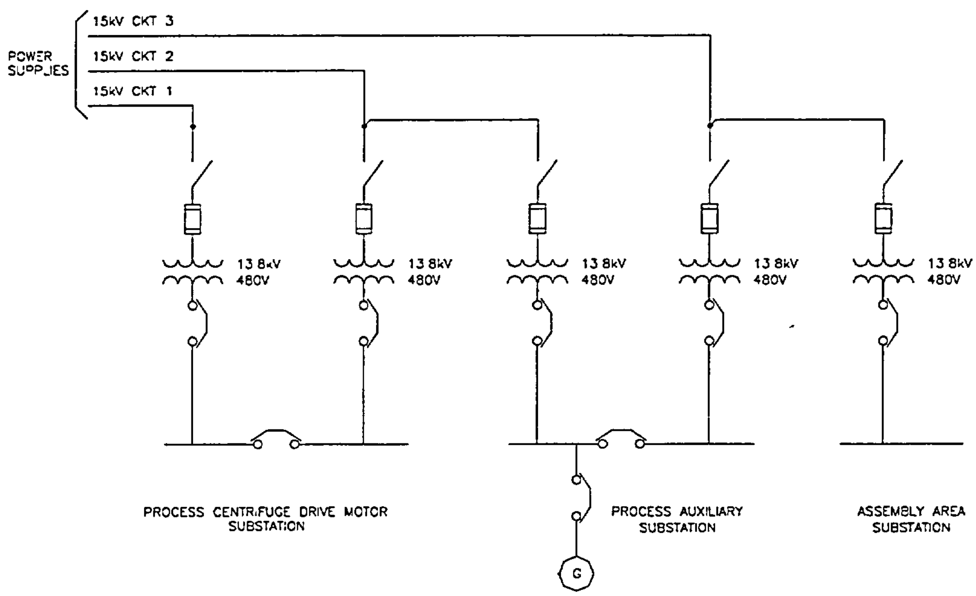

Figure 1.1-14
Lead Cascade Electrical One Line Diagram

1.2 Institutional Information

USEC Inc. is the applicant for the American Centrifuge Lead Cascade Facility license to possess and use special nuclear, source, and by-product material.

1.2.1 Corporate Identity

USEC is a global energy company and the world's leading supplier of enriched uranium fuel for commercial nuclear power plants. USEC, including its wholly owned subsidiaries, was organized under Delaware law in connection with the privatization of the Corporation.

USEC is responsible for the design, fabrication, installation, operation, maintenance, modification, and testing of the Lead Cascade that is located at PORTS. PORTS is being maintained in Cold Standby status by the Corporation (a wholly owned subsidiary of USEC) under contract to the DOE.

USEC's principle office is located at 6903 Rockledge Drive, Bethesda, MD 20817. USEC is listed on the New York Stock Exchange under the ticker symbol USU. Private and institutional investors own all outstanding shares of USEC. The principal officers of USEC are listed below and all are citizens of the United States.

William H. Timbers, President and Chief Executive Officer
Dennis R. Spurgeon, Executive Vice President and Chief Operating Officer
Sydney M. Ferguson, Senior Vice President
Timothy B. Hansen, Senior Vice President, General Counsel, and Secretary
Philip G. Sewell, Senior Vice President,
Henry Z. Shelton, Jr., Senior Vice President and Chief Financial Officer

The NRC has issued Certificates of Compliance to the Corporation to operate the Paducah and Portsmouth Gaseous Diffusion Plants (Docket Numbers 70-7001 and 70-7002, respectively). Consistent with the requirements in 10 CFR 76.22 and in connection with the issuance of these Certificates, the NRC has determined that USEC is neither owned, controlled, nor dominated by an alien, a foreign corporation, or a foreign government.

The mailing address for the Lead Cascade Project is:

USEC Inc.
Lead Cascade Project
P. O. Box 628
Piketon, Ohio 45661

1.2.1.1 Facility Site Location

The Lead Cascade is located at PORTS. PORTS is located at 39° 00' 30" north latitude and 83° 00' 00" west longitude measured at the center of the plant, on an approximate 3,708-acre federally owned reservation in Pike County, Ohio. The largest cities within an approximate 50-mile radius are Portsmouth, Ohio, located approximately 27 miles to the south, and Chillicothe, Ohio, located approximately 27 miles to the north. PORTS occupies approximately 700 security-fenced acres about one and one half miles east of U.S. Route 23 and two miles south of State Route 32, and two miles east of the Scioto River.

USEC, through its subsidiary (the Corporation), leases PORTS from the DOE. The Lead Cascade is within the space leased by USEC from the DOE.

1.2.1.2 Other Reservation Activities

PORTS operates in accordance with a NRC Certificate of Compliance issued pursuant to 10 CFR Part 76 requirements. The Corporation's operations include:

- Maintaining PORTS in Cold Standby status under a contract with the DOE;
- Performing uranium deposit removal activities in the cascade facilities; and
- Removing technetium (^{99}Tc) from potentially contaminated uranium feed in accordance with the June 17, 2002 agreement between USEC and the DOE.

The Corporation also possesses a license for radioactive material operations from the State of Ohio laboratory and associated support activities. This license encompasses laboratory analyses, in-field analyses for radioactive material deposits, and health physics survey and characterization activities.

In addition to the Corporation's operations, the DOE is engaged in environmental restoration activities in a number of locations on the reservation and utilizes contractors and sub-contractors to perform this work. DOE self-regulates these activities. Additionally, the Ohio National Guard maintains an area on the PORTS reservation for the maintenance, reconditioning, and storage of equipment. No ordnance is permitted. The activities are accomplished in and around the X-751 facility, located on the south end of the site.

1.2.2 Financial Qualifications

The Lead Cascade is financed by USEC. The refurbishment would employ an average of 25 workers for a 13-month period. Upon start-up, approximately 45 full-time employees staff the Lead Cascade for the limited period of planned operations. The Lead Cascade refurbishment and operating costs are documented in Appendix D of the Environmental Report for the American Centrifuge Lead Cascade Facility.

As reported in USEC's fiscal year 2002 Annual Report (Reference 1), based on customers' estimates for enrichment requirements and certain other assumptions, including estimates of inflation rates, at June 30, 2002, USEC had long-term requirements contracts aggregating $4.5 billion through fiscal 2011 (including $2.7 billion through fiscal 2005). Net income amounted to $16.2 million (or $.20 per share) in fiscal 2002.

USEC is the sole provider of funds for the construction and operation of the Lead Cascade. Expenditures related to the Lead Cascade, including any related cost over-runs, will be paid out of existing and projected cash flows from on-going operations. In light of its strong cash flow and cash position, USEC has confidence in its ability to complete construction and operation of the Lead Cascade while maintaining public health and safety and protection of the environment.

1.2.3 Type, Quantity, and Form of Licensed Material

The type, quantity, and form of NRC-regulated special nuclear, source, and by-product material are shown in Table 1.2-1.

1.2.4 Authorized Uses

The Lead Cascade enriches UF_6 up to 10 wt. percent ^{235}U. The Lead Cascade is operated on recycle where the enriched product stream is recombined with the depleted stream prior to being re-fed to the cascade. No product withdrawals are made from the Lead Cascade except for samples taken for laboratory analysis. Withdrawal of small quantities of depleted material may also be performed on an infrequent basis for operational considerations, with subsequent addition of feed to the cascade. The Lead Cascade may possess up to 250 kg UF_6. The specific authorized uses for each class of NRC-regulated material are shown in Table 1.2-2.

1.2.5 Special Exemptions or Special Authorizations

Similar to GDP operations, the following exemption to the applicable 10 CFR Part 20 posting and labeling requirements are identified in Section 4.8.1 of this license application:

- UF_6 feed, product, and depleted uranium cylinders, which are routinely transported inside the reservation boundary between facility locations and/or storage areas at the facility, are readily identifiable due to their size and unique construction, and are not routinely labeled as radioactive material. UF_6 cylinders are constantly attended by qualified radiological workers during movement.

The following exemption to the applicable 10 CFR 70.50 reporting requirement is identified in Section 11.6.6 of this license application:

- Because of the comprehensive nature of event follow-up reports, the event analysis and root cause determinations are often not completed within 30 days. Thus, the initial 30-day report required by the regulations may be incomplete and a supplemental report must be prepared when the information is available. In recognition of this, follow-up written reports for the Lead Cascade are submitted within 60 days of an event, consistent with the exemption granted to the GDPs for reporting of events pursuant to 10 CFR 76.120(d)(2) (67 *Federal Register* 68699, November 12, 2002).

The following Special Authorization has been identified in this license application:

- Surface Contamination Release Levels for Unrestricted Use – Items may be released for unrestricted use if the surface contamination is less than the levels listed in Table 4.6-1.

1.2.6 Security of Classified Information

USEC is required by 10 CFR 70.22(m) to submit, as part of its application for a license for the Lead Cascade, a plan describing the facility's proposed security procedures and controls, as set forth in 10 CFR Part 95, for the protection of classified matter. USEC satisfied this requirement by submission of its plan for the protection of classified matter as Chapter 2 of the Lead Cascade Security Program. The Lead Cascade Security Program was submitted for NRC review on July 3, 2002.

Table 1.2-1
Lead Cascade Possession Limits

Type of Material	Atomic Number	Physical State	Chemical Form	Possession Limit	Description
A. Source Material	92	Solid and gas	UF_6, UF_4, UO_2F_2, oxides, and other compounds	250 kg UF_6 169 kg U	Uranium (including natural and depleted) and daughter products and process contaminants and wastes
B. Source Material	90	Solid	Soluble and insoluble chemicals, metal	1.0 Ci	Instrument calibration sources, plated metallic sources, instrument check sources
C Special Nuclear Material[a]	92	Solid and gas	UF_6, UF_4, UO_2F_2, oxides, metal, and other compounds	700 g ^{235}U	Uranium enriched in isotope 235 up to 10 percent by weight, uranium daughter products and process contaminants and wastes, to include: (l) instrument calibration and check sources, or (2) material that may be in process and/or held up in facilities and equipment from Lead Cascade operations
	94	Sealed source Sealed glass ampules		0.5 Ci 3 0 Ci	Instrument calibration sources, NDA Instrument calibration sources, NDA
D By-Product Material	3-89, 91	Sealed source		1 0 Ci with no single isotope to exceed 100 mCi, except as noted below	Calibration, instrument internal source Instrument calibration and check sources
	27 Co-60	Sealed Source		1 0Ci	Calibration, NDA
	38 Sr-90	Sealed Source		0 5 Ci	Calibration

Table 1.2-1 (continued)
Lead Cascade Possession Limits

Type of Material	Atomic Number	Physical State	Chemical Form	Possession Limit	Description
D By-Product Material (continued)	43 Tc-99	Sealed Source		1.0 Ci	Calibration
	55 Cs-137	Sealed Source		1.0 Ci	Calibration, NDA
	61 Pr-147	Sealed Source		0.5 Ci	Calibration
	70 Yb-169	Sealed Source		1 0 Ci	Calibration, NDA
	81 Tl-207	Sealed Source		1 0 Ci	Calibration
	93, 96, 97, 99, 100	Sealed Source		0.5 Ci	Calibration
	95	Sealed Source	Oxides, metals	1.0 Ci	Calibration
	98	Sealed Source	Oxides, metals	1.0 Ci	Calibration, NDA

a. See 10 CFR Part 70 definitions. Special nuclear material means (1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of Section 51 of the Act, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing, but does not include source material.

Table 1.2-2
Authorized Uses of NRC-Regulated Materials

Material Class	Authorized Use
A. Source Material, Element 92	1. Enrichment of uranium up to 10 percent enrichment by weight ^{235}U
	2. Receipt, storage, inspection, and acceptance sampling of cylinders containing uranium
	3. Filling and storage of cylinders of natural uranium and uranium depleted in ^{235}U
	4. Cleaning and inspection of cylinders used for the storage and transport of process product and tails containing source or special nuclear material
	5. Storage of process wastes containing uranium, transuranic elements, and other contaminants and decay products
	6. Process, characterize, package, or store low-level radioactive and mixed wastes
	7. Radiation protection, process control and environmental sample collection, analysis, instrument calibration, and operation checks
	8. Maintenance, repair, and replacement of process equipment
	9. Heating cylinders and feeding contents into the centrifuge process
	10. Transfer between cylinders
B. Source Material, Element 90	1. Calibration and use of portable radiation protection and fixed laboratory equipment
	2. Process, characterize, package, or store low-level radioactive and mixed waste

Table 1.2-2 (continued)
Authorized Uses of NRC-Regulated Materials

Material Class	Authorized Use
C. Special Nuclear Material	1. Filling and storage of cylinders containing uranium enriched up to 10 percent by weight ^{235}U 2. Nondestructive testing and analyses of process streams 3. Cleaning and inspection of cylinders used for the storage and transport of process feed, product, and tails containing source or special nuclear material 4. Storage of process wastes containing uranium, transuranic elements, and other contaminants and decay products 5. Process, characterize, package, or store low-level radioactive and mixed wastes 6. Radiation protection, process control and environmental sample collection, analysis, instrument calibration, and operation checks 7. Maintenance, repair, and replacement of process equipment 8. Heating cylinders and feeding contents into the centrifuge process
D. Byproduct Material, Elements 3-89, 91	1. Radiation protection, process control, and environmental sample collection, analysis, instrument calibration, and operation checks 2. Nondestructive testing of product and product streams 3. Storage of process wastes containing uranium, transuranics, process contaminants, and decay products 4. Process, characterize, package, or store low-level radioactive and mixed wastes
Elements 93, 95 to 100	1. Calibration and use of portable radiation protection and fixed laboratory equipment 2. Nondestructive testing of product and product streams 3. Storage of process wastes containing uranium, transuranics, process contaminants, and decay products 4. Process, characterize, package, or store low-level radioactive and mixed wastes

1.3 Site Description

This section describes the Lead Cascade's location and description, nearby roadways and bodies of water, and significant geographical features.

The Lead Cascade is located on DOE-owned land in rural Pike County, a sparsely populated area in south central Ohio. Specifically, the Lead Cascade is located on the PORTS reservation in the former GCEP facilities. (Figure 1.1-1) The facilities are leased by USEC, through its subsidiary (the Corporation), from the DOE. The PORTS reservation has been studied and characterized extensively by both DOE and USEC.

1.3.1 Geography

The PORTS reservation is on the east side of the Scioto River approximately equidistant between Portsmouth and Chillicothe, Ohio.

The Scioto River Valley is one mile west of the site. The Scioto River, approximately two miles west of the site, is a tributary of the Ohio River, and their confluence is approximately 25 miles south of the PORTS reservation. With the exception of the Scioto River floodplain, which is farmed extensively, the area around the site consists of marginal farmland and forested hills. The only other body of water located near the site is Lake White, located approximately six miles north of the site.

Two major four lane highways: U.S. Route 23, traversing north-south, and State Route 32/124, traversing east-west, service the PORTS reservation. Commercial air transportation is provided through the Greater Cincinnati International Airport (approximately 100 miles west), the Port Columbus International Airport (approximately 75 miles north), or the Tri-State Airport (approximately 55 miles south-east). The Greater Portsmouth Regional Airport, serving private and charter aircraft, is located approximately 15 miles southeast near Minford, Ohio, and the Pike County Airport, located north of Waverly, is a small facility for private planes.

The entire PORTS reservation on which the Lead Cascade facilities are located is marked and bounded by signs and fences (barbed wire in the wooded areas). Where roads cross the boundary, gates are in place to serve as barriers if needed. PORTS reservation boundaries are identified in Figure 1.1-1. The reservation boundary is the controlled area boundary specified in 10 CFR 70.61(f). Most buildings and activities at the site (including the Lead Cascade facilities) are located within the next level of control, a Property Protection Area or Controlled Access Area (CAA), both surrounded by a security fence. Access to this fenced area is gained only with approved identification. In addition, the Lead Cascade is located within its own CAA. A topographic map of the PORTS reservation is provided in Figure 1.3-1.

1.3.2 Demographics

The PORTS reservation is located in Pike County, which is primarily rural in nature. With the exception of the Scioto River floodplain, which is farmed extensively, the area around the site consists of marginal farmland and forested hills. The remaining counties in the vicinity are also largely rural in character, except near the towns of Portsmouth in Scioto County and Chillicothe in Ross County.

1.3.2.1 Area Residential Population

The nearest residential center and the closest town to the site is Piketon, located in Pike County about four miles north of the site on U.S. Route 23 with a population of 1,907 in 2000. The largest town in Pike County is Waverly, about eight miles north of the site, with a population of 4,433 in 2000. Chillicothe, in Ross County about 27 miles north, is the largest population center in the Region of Influence with a population of 21,796 in 2000. Other population centers include Portsmouth, about 27 miles south in Scioto County, and Jackson, about 26 miles east in Jackson County, with populations of 20,909 and 6,184 in 2000, respectively. Table 1.3-1 presents historic and projected population in the Region of Influence and the state (Reference 2). The total population within the five-mile radius of the site is 5,836 (Figure 1.3-2).

1.3.2.2 Significant Transient and Special Populations

In addition to the residential population, there are institutional, transient, and seasonal populations in the PORTS area.

1.3.2.2.1 Schools

The two school systems in the area are the Pike County Schools and the Scioto County Schools. However, only Pike County has school facilities within five miles of the facility: two elementary schools, one that also has a preschool included; one high school; and a vocational school. The combined enrollment of these schools for the year 2002 was approximately 2,387 (Reference 3). The total school population within five miles, including faculty and staff, is 2,681. The proximity of these schools to the site and their enrollments are shown in Figure 1.3-3.

Three facilities within five miles of the PORTS reservation provide day care or schooling for preschool-aged children and after-school care for school-aged children. One facility, licensed to accommodate 320 children, is located in Piketon; the other, licensed to accommodate 70 children, is located near the PORTS reservation boundary. The third facility is consolidated in the numbers provided above for the elementary school (Reference 3). The locations of these facilities are shown in Figure 1.3-3.

1.3.2.2.2 Hospitals and Nursing Homes

Pike Community Hospital is the hospital closest to the site, located approximately 7.5 miles north of the facility on State Route104 south of Waverly. The facility has 37 licensed beds and operates at full capacity. No other acute care facilities are located in Pike County. The location of Pike Community Hospital is shown in Figure 1.3-3. Adena Health Center operates an urgent care facility approximately 7.5 miles north of the site.

Two licensed nursing homes are located near Piketon and one in Wakefield; all are located within five miles of the site. The largest of these facilities is a 201-bed facility in Piketon. The combined licensed capacity of the facilities neighboring the site is 282. Figure 1.3-3 depicts these facilities and shows the number of beds per facility (Reference 3).

1.3.2.2.3 Recreation Areas and Recreational Events

No significant recreational areas are on the site; recreational activities for employees are held offsite.

Offsite recreational areas include the Brush Creek State Forest, a 0.5 square mile portion of which is within five miles southwest of the PORTS reservation. Usage of this area is extremely light and is estimated to be 20 persons/year, primarily hunters and mushroom pickers. The location of Brush Creek State Forest is identified in Figure 1.3-3 (Reference 4).

Usage of Lake White State Park (Figure 1.3-3), located approximately six miles north of the site, is occasionally heavy and concentrated on the 107 acres of land closest to the lake. Most of the land surrounding the lake is privately owned. The 350-acre Lake White offers recreations, such as, boating, fishing, and swimming. There are 23 campsites for primitive overnight camping (Reference 5).

1.3.2.3 Uses of Nearby Land and Waters

Land within five miles of the site is used primarily for farms, forests, and urban or suburban residences. About 25,430 acres of farmland, including cropland, wooded lot, and pasture, lie within five miles of the site. The cropland is located mostly on or adjacent to the Scioto River flood plain and is farmed extensively, particularly with grain crops. The hillsides and terraces are used for cattle pasture. Both beef and dairy cattle are raised in the PORTS area.

The only significant industry in the vicinity is located in an industrial park south of Waverly. The industries include a cabinet manufacturer and an automotive parts manufacturer. These industries do not present any potential hazards to Lead Cascade operations.

Approximately 24,400 acres of forest lie within five miles of the site. This includes some commercial woodlands and a very small portion of Brush Creek State Forest.

No known public or private water supply draws from the Scioto River (Reference 4).

1.3.3 Meteorology

This section provides a meteorological description of the site and its surrounding area. The purpose is to provide meteorological information necessary to understand the regional weather phenomena of concern for the site operations and to understand the basis for the dispersion analyses performed (Reference 4).

1.3.3.1 Regional Climatology

Located west of the Appalachian Mountains, the region around the site has a climate essentially continental in nature, characterized by moderate extremes of heat and cold and wetness and dryness (Reference 4). July is the hottest month, with an average monthly temperature of 74°F, and January is the coldest month with an average temperature of 30°F. The highest and lowest daily temperatures from 1951 to 1980 were 103 and –25°F on July 14, 1954, and February 3, 1951, respectively.

Moisture in the area is predominantly supplied by air moving northward from the Gulf of Mexico (Reference 4). Precipitation is abundant from March through August and sparse in October and February. The average annual precipitation at Waverly, Ohio, for the period from 1951 to 1980 was 40.4 inches (in.) (Reference 4). The greatest daily rainfall during this period was 3.38 in., occurring on June 26, 1971. Snowfall occurrence varies from year to year, but is common from November through March. The average annual snowfall for the area is about 22 in., based on the 1951-1980 data. During that time period, the maximum monthly snowfall was 25.4 in., occurring in January 1978.

Occasionally, heavy amounts of rain associated with thunderstorms or low pressure systems will fall in a short period of time. The U.S. Weather Bureau has published values of the total precipitation for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. The results for the geographic locale including the site are summarized in Table 1.3-2. A local drainage analysis for extreme storms at the site has been performed (see Reference 4).

The predominant winds at the site blow from the south or southwest and at times from the north. The average wind speed is about 5 miles per hour (mph). On the average, from 1953 to 1989, 14 tornadoes per year were reported in Ohio, but the total varies widely from year to year (e.g., 43 in 1973 and 0 in 1988). Pike County, where the PORTS reservation is located, had two tornadoes during the 20-year period from 1953 to 1972 (Reference 4).

1.3.3.2 On-Site Meteorological Measurements Program

Since January 1995, a new 200-ft (60-m) tower has been in use. It is equipped with instrument packages at the 33-, 98-, and 200-ft (10-, 30-, and 60-m) levels. In addition, ground-level instrumentation measures solar radiation, barometric pressure, precipitation, and soil temperatures at 1- and 2-ft depths.

1.3.3.3 Local Meteorology

Hourly temperatures at the 33- and 105-ft (10- and 32-m) levels above the ground were recorded at the site meteorological tower before 1995. At each level, 8,555 of the possible 8,760 data points are available. The seasonal temperature variation and the daily temperature fluctuations are consistent with long-term averages. The two sets of temperature readings at the site meteorological tower are highly correlated, as one would expect. Since January 1995, temperatures at the 33-, 98-, and 200-ft (10-, 30-, and 60-m) levels have been measured at the new tower.

Of the 8,760 possible hourly wind speed and wind direction data for 1993, 8,430 are available for wind speed and 8,423 for wind direction. The average wind speeds were 3.7 and 6.0 mph at 33- and 105-ft (10- and 32-m) levels, respectively. Wind roses at 33- and 105-ft (10- and 32-m) at the site constructed from the 1993 data are compared in Figure 1.3-4.

Wind damage at the plant is not likely to result in a significant release of hazardous material. Wind is more likely to cause exterior damage to the buildings without extensive damage internally. In addition, high winds will rapidly disperse any hazardous material released as well as reduce exposure times down wind. Therefore, the risk of serious injuries and/or deaths is substantially low for high winds. The Lead Cascade facilities are designed for a wind loading criteria meeting basic wind speeds of 90 mph at 30 ft above ground.

Tornadoes do occur in Southern Ohio; however, specific analyses of the frequency of tornadoes in the region show that they are rare. The actual damage expected to cascade internal equipment and structures is expected to be minimal on the cascade floor due to the large reservoir of air between the building roof and the cascade floor. The process building containing the Lead Cascade is designed with a tornadic wind of 100 mph and a rate of atmospheric change of 7 pounds per square foot (psf)/second for a duration of 3 seconds. Other Lead Cascade facilities are designed for a wind velocity of 90 mph at 30 feet above ground except standard prefabricated buildings used as offices, warehouses and nonessential facilities less than 30 feet in height. This last category of facilities is designed for a horizontal wind pressure of 20 psf.

Additionally, the Lead Cascade facilities are designed with a ground snow load of 20 psf.

Because PORTS is not a coastal location, the effects of hurricanes are not considered other than increased rainfalls as remnants of the storm affected weather patterns in the upper Ohio River Valley.

Severe storms can and are likely to produce lightning strikes, which can interrupt and cause a partial power failure. However, the buildings are heavily grounded and some have installed lightning protection. PORTS is in an area that has less than 40 days annually with a thunderstorm. PORTS is at a “moderate” risk value of loss due to lightning strikes. Lightning has not been a problem for these structures, since initial construction in the mid-1980s. The power systems are designed to handle lightning strikes.

1.3.4 Surface Hydrology

This section describes the surface hydrology on and around the PORTS site.

1.3.4.1 Hydrologic Description

The significant surface streams and waterways affecting the PORTS reservation are discussed in this section.

1.3.4.1.1 Scioto River Basin

The PORTS reservation is located near the southern end of the Scioto River basin, which has a drainage area of 6,517 square miles. The headwaters of the Scioto River form in Auglaize County in north central Ohio. The river flows 235 miles through nine counties in Ohio, and through the cities of Columbus, Circleville, Chillicothe, and Portsmouth. At Portsmouth, in Scioto County, the river empties into the Ohio River at river mile (RM) 356.5. The slope of the Scioto River channel averages about 1.7 ft/mile between Columbus and Portsmouth (Reference 4).

Upstream retarding basins are located on tributaries throughout the Scioto River basin. The upstream retarding basin nearest the site forms Lake White along Pee Pee Creek, about six miles north of the site (Figure1.3-5). The spillway of the reservoir is located at an elevation of 567 ft, while the roadway along the top of the dam is at an elevation of 577 ft (Reference 4). Pee Pee Creek empties into the Scioto River south of Waverly at RM 40.

The U. S. Geological Survey (USGS) has collected stream-flow data for the Scioto River at Higby, Ohio, since 1930. The gauging station is located approximately 13 miles north of the site at RM 55.5. The drainage area of the Scioto River basin above Higby is 5,130 square miles. The river flows measured at Higby from 1930 to 1991 range from 177,000 cubic feet per second (cfs) on January 23, 1937, to 244 cfs on October 23, 1930, and average 4,654 cfs. The 1937 flood had a peak water elevation of 593.7 ft. The consecutive seven-day minimum discharge of record is 255 cfs, which occurred during October 19-25, 1930 (Reference 4).

Water in the vicinity of the site is available from Lake White, the Scioto River, and groundwater supplies (Reference 4). Most of the water used is taken from groundwater. Three municipal water supply facilities are located in the segment of the Scioto River between Higby and the confluence with the Ohio River (and all three use groundwater wells). Both Waverly and Piketon, located at RM 40 and 34, respectively, use groundwater wells. The city of Portsmouth uses water from the Ohio River through an intake at the Ohio River at RM 350.8, which is 5.7 miles upstream from the mouth of the Scioto River (Reference 4).

Water used at the site normally comes from groundwater. Currently, all water is supplied by wells in the Scioto River alluvium. These wells are located near the east bank of the Scioto River, downstream from Piketon. Four well fields (X-605G, X-608A, X-608B, and X-6609) have the capacity to supply reliably between 36.4 and 40.2 cfs.

1.3.4.1.2 PORTS Reservation Area

The site is located about 2.5 miles east of the confluence of the Scioto River and Big Beaver Creek near RM 27.5 (Figure 1.3-5). The plant site occupies an upland area bounded on the east and west by ridges of low-lying hills that have been deeply dissected by present and past drainage features. The plant nominal elevation is 670 ft, which is about 130 ft above the normal stage of the Scioto River. Both groundwater and surface water at the site are drained from the plant site by a network of tributaries of the Scioto River.

Both Big Beaver and Little Beaver Creeks receive runoff from the northeastern and northern portions of the site. Little Beaver Creek, the largest stream on the property, flows northwesterly just north of the main plant area (Figure 1.3-5). It drains the northern and northeastern parts of the main plant site before discharging into Big Beaver. About two miles from the confluence of the two creeks, Big Beaver Creek empties into the Scioto River at RM 27.5 (Figure 1.3-5). Upstream from the plant, Little Beaver Creek has intermittent flow throughout the year.

In the southeast portion of the site, the southerly flowing Big Run Creek (Figure 1.3-5) is situated in a relatively broad, gently sloping valley where significant deposits of recent alluvium have been laid down by the stream (Reference 4). This intermittent stream receives overflow from the south holding pond (X-230K), which collects discharge of storm sewers on the south end of the plant site. Big Run Creek empties into the Scioto River about five miles downstream from the mouth of Big Beaver Creek (Figure 1.3-5).

Two unnamed intermittent streams drain the western portion of the plant site (Figure 1.3-5). The stream in the site's southwest portion flows southerly and westerly in a narrow, steep-walled valley with little recent alluvium. It drains the southwest corner of the facility via the southwest holding pond. The stream near the west central portion of the plant site flows northwesterly and receives runoff from the central and western part of the site via the west drainage ditch. Both unnamed streams flow directly to the Scioto River and carry only storm water runoff (Reference 4).

Little Beaver Creek receives 39 percent of the total PORTS reservation effluents, Big Run Creek, 9 percent, and the two unnamed tributaries, 25 percent. The remaining 27 percent is discharged directly to the Scioto River through two pipelines. Treated effluents from a sanitary sewage plant are conveyed about two miles to the Scioto River via a 15-in. vitreous clay sewer line at Outfall 003; blowdown from the recirculating cooling water system enters the Scioto via Outfall 004 (Reference 4).

1.3.4.1.3 Site and Facilities

The PORTS reservation nominal elevation is 670 ft, which is about 130 ft above the normal stage of the Scioto River. The top-of-slab floor elevations for the Lead Cascade facilities are at approximately 671 ft. Storm water that falls at the site is drained to local Scioto River tributaries by storm sewers. The flow of storm water is further controlled by a series of holding ponds downstream from the storm sewer outfalls.

The perimeter road, as shown in Figure 1.3-6 (located in Appendix A of this license application), serves as a hydrologic boundary that prevents storm water runoff from backing up into the Lead Cascade facilities. Once storm water has been discharged onto the outer side of the Perimeter Road to the north, west, and south, the water flows downhill to local creeks and runs. To the east and southeast, the Perimeter Road acts as a diversion dam that directs storm water runoff to Big Run Creek. The northeastern corner of the Perimeter Road protects the main gaseous diffusion plant process buildings from flooding that could occur if the X-611B sludge lagoon dam failed. The relationship of storm water holding ponds, located along the outside of Perimeter Road shown in Figure 1.3-6, to the topographic elevations, indicated in Figure 1.3-7 (located in Appendix A of this license application), emphasizes the overall function of the site surface water drainage system that has been described here (Reference 4).

Water used at the site is supplied by wells sunk into the Scioto River alluvium. The raw water is pumped through a 48-in. waterline from the X-608 Raw Water Pump House and through a 30-in. waterline from X-6609 to the Water Treatment Plant, X-611, located near the northeastern corner of the site just outside the Perimeter Road. Pump House X-608, near the well fields, can also pump water from the Scioto River and is a backup system that is used only when the well systems are unable to produce sufficient water to meet the plant demand. The well fields and the X-608 pump house may expect flooding (Reference 4). Although equipment in X-608 and X-6609 well fields is designed to operate without the effects of flooding, the equipment in the X-608 pumphouse is located above the 571-ft level.

1.3.4.2 Flood History

The average annual discharge at the Higby station for the period of record (1930-1991) is 4,654 cfs, while the maximum discharge of record is 177,000 cfs observed on January 23, 1937. The stage of the 1937 flood was 593.7 ft above mean sea level (amsl). The historical flood stage of the Scioto River next to the site was estimated to be 556.7 ft by using the estimate that the Scioto River drops approximately 37 ft between the Higby gauging station (RM 55.5) and the mouth of Big Beaver Creek (RM 27.5). Elevations for floods (with three recurrence intervals) at the confluence of the Scioto River and Big Beaver Creek (RM 27.5), estimated by the U. S. Army Corps of Engineers, are compared with the site nominal grade elevation in Table 1.3-3 (Reference 4).

Since the site has a nominal elevation of about 670 ft amsl (Figure 1.3-7) and about 113 ft above the historical flood level for the Scioto River in the area, the site has not been affected by flooding of the Scioto River.

1.3.4.3 Probable Maximum Flood

The plant elevation is greater than the maximum historic levels recorded for the Scioto River in the area and the 500-year flood predicted by the U.S. Army Corps of Engineers.

However, a calculation of the Probable Maximum Flood (PMF) was also performed. The details of a method of calculating the PMF are discussed in NRC Regulatory Guide 1.59, *Design Basis Floods for Nuclear Power Plants.* It is based on the drainage area and the location of the watershed involved. The drainage area of the Scioto River basin above Higby is 5,131 square miles and that of the whole basin is 6,517 square miles (Reference 4). The drainage area of the Scioto River above the site (RM 27.5) is between those two values. A conservative estimate for the PMF discharge of the Scioto River at either Higby or the site is approximately 1,000,000 cfs. This value is used as the PMF discharge of the Scioto River at the site, which including the wind/wave activity contribution, would correspond to a flood level of 571 ft, well below the nominal 670 ft elevation of the site.

Two widely accepted probabilistic methods, the log Pearson III distribution and the Gumbel method, have been considered. The 10,000-year flood discharges of the Scioto River at Higby determined with these two methods are 526,000 and 280,000 cfs, respectively. Both of these discharge rates are smaller than that of the PMF. The PMF is, therefore, the bounding event in determining the evaluation basis loads from flooding for the site.

Conservative estimates indicate that the failure of upstream dams would not threaten the safety of the PORTS reservation because of the high nominal plant grade elevation (Reference 4). In addition, the limited storage capacities of the reservoirs, the large stream distances of these dams from the site, and friction and form losses would make the actual wave heights even smaller than the estimated values. Discharges were considered of dam failures at full pool combined with that of either a 25-year flood or one-half of the PMF of the Scioto River. The result involving one-half of the PMF would result in a higher value, which is also somewhat greater than that of the PMF. However, this combined extreme flood would not threaten the safe operations of the site because of the high nominal plant grade elevation, similar to the case of the PMF.

1.3.4.3.1 Effects of Local Intense Precipitation

Storm Intensities and 10,000-Year Storms

The U.S. Weather Bureau has published values of the total precipitation reaching the ground for durations from 30 minutes to 24 hours and return periods from 1 to 100 years (Reference 4). The results for the geographic locale including the site are summarized in Table 1.3-2. Values for 10,000-year storms are extrapolated from smaller duration values using a least-squares method. The rainfall intensity for a given storm listed in Table 1.3-2 can be obtained by dividing the total precipitation by the duration.

To determine whether the influx of rainwater from a 10,000-year storm can be conveyed away from plant structures, the intensity versus duration relation for 10,000-year storms at the site needs to first be established. This was done by adopting an established empirical intensity versus duration relation and using values listed in the last row of Table 1.3-2 and a nonlinear least-squares methodology (Reference 4). The resultant graph is shown in Figure 1.3-8. At small durations, although the intensities are high, the total precipitations are small. At large durations, the reverse is true.

Results for Creeks

The stage-discharge relationships for the five streams draining the site facilities were evaluated using the estimated cross sections and Manning's formula with n = 0.15, a value typical for flood plains and very poor natural channels. The peak runoffs of these streams can be calculated using the natural runoff model and the intensity vs. duration relation shown in Figure 1.3-8. Local flooding for different streams are caused by 10,000-year storms with differing duration values because each watershed drains a basin of a different size (Reference 4). The relatively large differences between nominal plant grade elevation and the calculated flood stage elevations for the five streams clearly indicate that the Lead Cascade facilities would not be inundated by these streams during a 10,000-year storm.

Results for Storm Sewers

In addition to the Manning's formula and the natural runoff model, the urban runoff model and an inflow-outflow balance method (Reference 4) were also used to assess the storm sewers. In each case, the duration that gives maximum peak discharge is determined and used as the 10,000-year storm.

The results indicate that the site would experience local ponding during a 10,000-year storm because the storm sewer system has insufficient capacity to convey the rainwater to the outfalls. The average depth of water around the base of the buildings would range from 3.91 to 5.08 in. The existing storm sewer system would require from approximately 1.8 to 9.9 hours to drain the excess storm water to the outfalls (Reference 4).

The effect of a clogged storm sewer system on the ponding depth has been considered (Reference 4). Because the storm sewer flow is approximately one-fourth of the total 10,000-year storm flow, the overland drainage system is the dominant factor in determining the water depth at the base of the buildings. Thus local ponding levels can be controlled by keeping natural surfaces within the security fence grassed, mowed, and free of high weeds, and by keeping debris from blocking urbanized surfaces. This would prevent water from backing up to higher levels. Ponding on the site is not expected to impact safe operations.

Results for Ponds and Lagoons

To assess whether failures of the local dams could conceivably jeopardize the safety of systems, holding ponds, lagoons, and retention basins formed by these dams were considered in the local drainage analysis. They include the west drainage ditch; X-2230N west-central holding pond, X-2230M southwest holding pond, X-230K south holding pond, east drainage ditch, X-701B holding ponds (northwest, central, and southeast portions), storm sewer L, X-230L north holding pond, X-611B Sludge Lagoon, and X-611A lagoons (north, middle, and south lagoons) (Reference 4). The surface elevations of all but the X-611B are well below the 670-ft minimum grade elevation of the Lead Cascade facilities.

The water elevation of the X-611B sludge lagoon at 668.8 ft is close to the 670-ft minimum grade elevation at the Lead Cascade facilities. The elevation of the top of the dam forming the lagoon is 676.3 ft and exceeds the 670-ft minimum. However, when the conservative estimate of flood wave height (4/9 of the dam height) is used, the flood elevation resulting from a break in the dam would be only 652.8 ft. The flood wave clearly poses no threat to the Lead Cascade facilities because it could not overtop Perimeter Road (Reference 4).

Results for Ditches and Culverts

The site storm sewer system discharges through each of the outfalls into a series of ditches, culverts, and holding ponds, with eventual discharge to nearby creeks or to the Scioto River directly.

Outfalls at the site have been analyzed to predict their response during a 10,000-year storm (Reference 4). Although some of the culverts would be incapable of carrying the influx of rainwater and some over-banking would happen during a 10,000-year storm, water surface elevations computed for flows in all of the related culverts are below grade elevation at the Lead Cascade facilities and would not cause local flooding at these buildings during a 10,000-year storm.

Effects of Ice and Snow

The PORTS reservation has a generally moderate climate. Winters in the area are moderately cold. On the average, there are 112 days per year below 32°F, but only approximately three days per year at or below 0°F. The average annual snowfall is 22 in. To estimate the extreme snowfall at the site, values for three surrounding cities are used. The maximum monthly snowfalls of record for Columbus (Ohio), Charleston (West Virginia), and Louisville (Kentucky) are 34.4, 39.5, and 28.4 in., respectively, measured in January 1978. If the largest value among the three is used for the site, and if an average density of 0.1 for freshly fallen snow is assumed (Reference 4), this snowfall corresponds to 3.95 in. of rainfall.

1.3.4.3.2 Probable Maximum Flood on Rivers

The maps and the procedure outlined in Section B.3.2.2 of NRC Regulatory Guide 1.59, *Design Basis Floods for Nuclear Power Plants,* were used to estimate the PMF discharge. The log-log plot of the data approximates a straight line. The drainage area of the Scioto River basin above Higby is 5,131 square miles, above Piketon is 5,824 square miles, and above the mouth of the river is 6,517 square miles. The drainage area of the Scioto River above the site (RM 27.5) is estimated from these values to be 6,000 square miles. PMF discharge of the Scioto River at the site as taken from the log-log plot is approximately 1,000,000 cfs. This value is adopted as the PMF discharge near the site (Reference 4).

Coincident Wind Wave Activity

A conservatively high wind velocity of 40 mph blowing over land from the most adverse direction was adopted to associate with the PMF elevation at the site in accordance with Alternatives I and II in Appendix A of NRC Regulatory Guide 1.59, *Design Basis Floods for Nuclear Power Plants*. The fetch length near the site during the PMF of the Scioto River was estimated from USGS topographic quadrangle maps having a 1:24,000 scale to be one mile. The increase of flood elevations of the Scioto River near the site due to this wind wave activity was estimated to be 1.8 ft (Reference 4). The PMF plus this coincident wind wave activity would have a flood stage of 571 ft.

Comparison of Flood Levels with PORTS Reservation Elevations

The nominal, top-of-grade elevation at the site is 670 ft, about 99 ft above the PMF plus wind wave activity flood stage of 571 ft. The top-of-slab floor elevation for the Lead Cascade facilities are at approximately 671 ft. The Scioto River during a PMF superimposed with wind wave activity; therefore, would not inundate these buildings.

The PORTS reservation water supply facility near the Scioto River, pump house X-608 and groundwater well fields, may expect flooding (Reference 4). Though the well fields are designated to operate without the effects of flooding, such impacts on the Lead Cascade cooling system would not result in a release of UF_6. Closing strategic valves can isolate the enrichment process, and during severe conditions all or part of the cascade can be shut down.

1.3.4.4 Potential Seismically Induced Dam Failures

The domino-type failure of dams upstream on the Scioto River, failures of individual dams on the tributaries of the Scioto River, and individual dam failures combined with either a 25-year flood or one-half of the PMF of the Scioto River may result in flood elevations that are comparable or even greater than that of the PMF 569 ft. However, even when a conservative wave height of 41.3 ft is used, this cascade of dam failures clearly would not threaten the site because the nominal plant grade elevation is 670 ft, which is 130 ft higher than the normal Scioto River level.

1.3.4.5 Channel Diversions and Ice Formation on the Scioto River

The ancient Newark River was a major channel for alluvium-bearing meltwater from the continental glaciations (Reference 4). This river system ended when its deep valley and those of other major south-draining streams were partially filled with silt, sand, and gravel outwash. The present Scioto River was developed on top of this glacial outwash during the final retreat of glaciers from the area (Reference 4). The Scioto River apparently has a smaller flow and hence a more restricted channel. Therefore, channel diversions of the lower stem of the Scioto River out of the ancient Newark River Valley are unlikely.

Ice occurs on all streams in the Ohio River basin, including its tributary, the Scioto River. Ice on the Scioto River should not affect the water supply to the site because the plant uses groundwater taken from near the river. Additionally, ice formation would not pose a threat of flooding to the site, given the high elevation of the plant relative to the river.

1.3.4.6 Low Water Considerations

Water used at the site can be supplied from wells in the Scioto River alluvium and pumped via existing waterlines to the Water Treatment Plant, X-611. The Pump House, X-608, near the well fields can also pump water from the Scioto River and is a backup system that is used only when the well systems are unable to produce sufficient water to meet the plant demand (Reference 4).

At the Higby gauging station, which is approximately 13 miles north of the PORTS reservation, the minimum river flow measured from 1930 to 1991 was 244 cfs on October 23, 1930 (Reference 4). The consecutive seven-day minimum discharge record of 255 cfs occurred during October 19-25, 1930 (Reference 4). The volumetric river flow is much greater than the site's water use.

1.3.4.7 Dilution of Effluents

The average discharge of the Scioto River near the site is 4,654 cfs. Potentially, this discharge rate has a large capacity for reducing the concentration of received contaminants. For example, the uranium discharged from the site through the local drainage system to the Scioto River was estimated to be 45 kg during 1990 (Reference 4). In 1990, the bulk of the uranium (76 percent) was discharged through Outfall 001 to Little Beaver Creek (Reference 4). Assuming a full dilution, this would result in an average uranium concentration of 1.1×10^{-5} milligrams per liter (mg/L) in the Scioto River.

1.3.5 Subsurface Hydrology

This section describes the subsurface hydrogeologic system in the Interior Low Plateaus region of southern Ohio in the vicinity of the PORTS reservation.

1.3.5.1 Regional and Area Characteristics

In the region surrounding the PORTS reservation in southeastern Ohio, groundwater is used for domestic and municipal drinking water supplies, irrigation, and industrial purposes. Larger demands are usually met by a combination of groundwater and surface water. A system of reservoirs is used for flood control in the Scioto River Basin, which also maintains surface water supplies during periods of low flow.

Aquifers in near-surface sand and gravel deposits adjacent to ancient or present surface drainage courses provide abundant quantities of water. Reliable quantities of groundwater from shallow bedrock aquifers are localized. While abundant quantities of satisfactory groundwater are available from deeper bedrock aquifers, depths as great as 1,000 ft make exploitation of those aquifers impractical except in the western part of the region. The quality of water from sand and gravel aquifers in the Scioto River Basin is usually classified as fair-to-excellent, while bedrock aquifers are classified as fair because of elevated iron content.

1.3.5.1.1 Aquifers

The subsurface hydrologic system near the site is composed of unconsolidated Pleistocene clastic sediments of glacial and alluvial origin in river valleys and of underlying Paleozoic bedrock units. Figures 1.3-9 and 1.3-10 show the general configuration of these valleys and bedrock units near the site.

The unconsolidated sediments aquifer consists of two distinct aquifers in the immediate vicinity of the site: the Scioto River glacial outwash aquifer and "other" alluvial aquifers, all of Quaternary Age. The Scioto River glacial outwash aquifer consists of permeable deposits of sand and gravel beneath the area adjacent to the river and occupies the ancient Newark River Valley. The other alluvial aquifers consist of deposits of clay and silt interbedded with lenses of sand and gravel, and they partially fill the pre-glacial drainage channels and major tributaries of the Scioto River. These latter aquifers, referred to as the Gallia aquifer of the Teays Formation, are of relatively lesser importance. Because of compositional differences related to their geologic history, the Scioto and Gallia aquifers are treated separately. Table 1.3-4 relates the Scioto River outwash, Gallia hydrogeologic units, and bedrock units to the regional stratigraphic setting.

The bedrock aquifer consists of Silurian through Mississippian limestones, sandstones, and shales. The distribution and use of most of the Silurian and Devonian aquifers is limited to the western portions of the state. For example, groundwater in the Greenfield limestone is used in the area about 50 miles west of the site. The bedrock aquifer near the site consists of the Mississippian-age Bedford Shale, Berea Sandstone, Sunbury Shale, and Cuyahoga Shale in ascending order (Reference 4).

Scioto River Glacial Outwash Aquifer

The Scioto River Valley is underlain by glacial outwash sediments and riverbed alluvium that were deposited during the Quaternary Period. It is one of the principal aquifers in Ohio. The unit extends from the confluence of the Scioto and Ohio rivers to the headwaters of the Scioto in north-central Ohio (Reference 4).

The glacial outwash deposits consist primarily of fine gravel and coarse sand that sometimes is interbedded with fine sand and silt and locally may contain small bodies of clay. These deposits are thickest, 70 to 80 ft, in a comparatively narrow incised bedrock channel, which in the Piketon area, generally underlies the west side of the river valley. The highly porous and permeable glacial outwash deposits are overlain by about 10 to 20 ft of fine-grained, poorly permeable river alluvium laid down by the modern Scioto River. The water table ranges generally from 10 to 15 ft below the ground surface, and the saturated thickness of the unit is about 40 to 65 ft. For the most part, the aquifer is unconfined (Reference 4).

The Scioto River outwash aquifer supplies municipal, commercial, and domestic water for the area west of the site (Reference 4). The Scioto River outwash aquifer is probably responsive to the stage of the present Scioto River.

Gallia Alluvial Aquifer

The Gallia alluvial aquifer, although similar to the Scioto River outwash aquifer by being Quaternary in age, differs in its geologic history and composition. The Gallia, consisting of silty sand and gravel, is the lower member of the Teays Formation. The overlying Minford Member consists of silt and clay. Where the Sunbury Shale is absent, the Gallia Sand overlies the Berea Sandstone. Because the Gallia represents localized infilling of an ancient streambed, its areal distribution is limited. The Gallia Sand is used locally as a source of water for municipal, commercial, and domestic purposes.

Bedrock Aquifer

Data describing the bedrock aquifer in the region surrounding the site are generally limited to published maps and hydrograph data from the ODNR, Division of Water. Such maps for Pike County and Jackson and Vinton Counties (Reference 4) indicate that the bedrock aquifer serves only domestic needs.

1.3.5.1.2 Regional Groundwater Use

The Scioto glacial outwash aquifer serves as the principal aquifer in the region. Water from this aquifer supplies domestic, agricultural, industrial, and municipal needs. Several municipalities use the aquifer for reserve capacity. Minor alluvial aquifers (including the Gallia) supply domestic needs locally.

1.3.5.1.3 Flow in the Regional Aquifers

Many details of the subsurface hydrologic system have been described at the site in USEC-02 (Reference 4). With respect to aquifer contamination, the two most important aquifers are the Berea Sandstone and the Gallia. The ability for environmental contaminants from facility operations and waste disposal activities to enter these aquifers and migrate off-site is the most important characteristic of the subsurface hydrologic system.

The potential for offsite contamination of regional aquifers is a function of the distribution of geologic units that might enhance cross-formational flow. The vertical head profile between the Berea and the Gallia is determined by the distribution of the Sunbury Shale. Where the Sunbury is absent or very thin, an upward vertical-head profile exists from the Berea to the Gallia. Where the Sunbury is present, a vertically downward head profile exists from the Gallia to the Berea. Thus, the proximity of onsite environmental contaminants to locations exhibiting downward vertical-head profiles poses the greatest potential for offsite contamination of the Berea. This flow from the Sunbury to the Berea would occur through fractures or deeply weathered zones in the Sunbury.

Groundwater flow at the site is controlled by the complex interactions between the Gallia and Berea units. The flow patterns are also affected by the presence and elevation of storm sewer drainpipes and their bedding and by the reduction in recharge caused by building and paved areas. Three principal discharge areas exist for all ground water: (1) Little Beaver Creek to the north and east; (2) Big Run Creek to the south; and (3) two unnamed drainages to the west. Groundwater flow patterns in both the Berea and Gallia are characterized by an east-west trending groundwater divide that passes through the site. Other groundwater divides are also present, dividing the flow system of each unit into four sub-basins in the Gallia and three in the Berea.

While contamination of the Berea aquifer from onsite activities is possible, due to the downward vertical-head profile from the Gallia, offsite monitoring has not detected contaminant concentrations above background levels (Reference 4). Additionally, dissolved solids exceeding 10,000 ppm within about five miles down gradient from the site make it unlikely that significant portions of the Berea drinking water resource would be adversely affected.

Precipitation is the primary source of recharge of these aquifers. Recharge at the site is estimated at between 2.3 and 11.7 in./year (Reference 4). Infiltration reaches the water table and moves laterally to areas of discharge or vertically to adjacent aquifers. The Gallia aquifer near or adjacent to surface drainage ways is likely in active communication with the surface water.

1.3.5.2 Site Characteristics

The site sits in a mile-wide former river valley (Portsmouth River Valley) surrounded by farmland and wooded hills with generally less than 100 ft of relief. The main plant area has a nominal elevation of 670 ft amsl about 130 ft above the stage of the Scioto River, which lies about 2.5 miles to the west. The Scioto River and its tributaries receive essentially all of the surface water and groundwater discharge at the site.

Geologic units controlling groundwater flow beneath the site are, in descending order, the Minford and Gallia unconsolidated units of the Quaternary age, and the Sunbury, Berea, and Bedford bedrock units of the Mississippian age (Table 1.3-4). The Mississippian Cuyahoga shale, the youngest bedrock unit in the area, forms the hills east and west of the main plant site. Also present in some places is up to 20 ft of artificial fill, which is predominantly Minford silt and clay.

The main groundwater flow system beneath the site is the Gallia sand and the lower unit of the Minford, the Minford silt. The Gallia sand and the lower Minford silt form the uppermost, unconfined aquifer (the Gallia aquifer) with a combined thickness of about 11 ft (Figure 1.3-11). The bottom of the Gallia aquifer has an elevation ranging from 630 to 640 ft amsl in the plant area.

The Gallia aquifer is partly surrounded by the Cuyahoga shale, which lies in the wooded hills around the site. The Sunbury shale underlies both the Gallia aquifer and the Cuyahoga shale. The Sunbury separates the Gallia aquifer from the underlying confined aquifer, the Berea sandstone. Where the Sunbury is absent or thin, the Berea aquifer and the overlying Gallia aquifer act essentially as one unit. About 100 ft of Bedford shale underlies the Berea aquifer over the entire site. The lower 10 ft of the Berea is very similar to the underlying Bedford shale (Reference 4).

1.3.5.2.1 Aquifers Beneath the Site

The Gallia exhibits the highest hydraulic conductivity of all aquifers on the site. Hydraulic conductivity values range from 0.11 to 150 feet per day (ft/d), with a mean of 3.4 ft/d (Reference 4). Groundwater flow directions in the Gallia are roughly from the center of the site toward the surrounding low-lying surface water drainage system. The ultimate discharge area for most groundwater is Little Beaver Creek to the north and east, Big Run Creek to the south, and two unnamed drainages to the west.

1.3.5.2.2 Aquifer Properties

At the site, the Berea Sandstone exhibits little spatial variation in hydraulic properties. The site-wide mean hydraulic conductivity for the Berea is 0.16 ft/d (Reference 4). The highest hydraulic conductivity in the Berea was measured as 0.35 ft/d at the X-616 area, where the unit has been slightly eroded and may be slightly weathered; the lowest hydraulic conductivity was measured is 0.1 ft/d at both X-231B and X-701B.

Groundwater elevations in the Berea Sandstone are determined by local geologic conditions. Measurements at the site between August 1988 and September 1989 indicate a mean water elevation of 646.15 ft mean sea level (MSL) with a standard deviation of 0.92 ft (Reference 4). A generally downward vertical gradient occurs between the Berea and overlying aquifer when overlain by the Sunbury Shale, which acts as an effective confining unit. Where the Sunbury is absent or very thin, an upward vertical gradient exists between the Berea and overlying aquifer. Groundwater flow in the Berea is expected to be similar to those of the Gallia except in the eastern part of the site, where the directions are generally toward the east and southeast.

Recharge from precipitation has been estimated to be 8.9 in./year using the 1985 data and the Thornthwaite method (Reference 4). This corresponds to about 25 percent of the total precipitation of 35.78 in. that year. In general, the estimated annual recharge rates vary from 3.3 to 11.7 in./year.

Little Beaver Creek to the north and east, Big Run Creek to the southeast, and the two unnamed tributaries to the west control groundwater flow in the Gallia and Berea aquifers by acting as local recharge or discharge areas. In some places, the large-diameter storm drain segments are partially below the elevation of the Gallia water table (Reference 4). These drains and surrounding gravel beddings may act as groundwater interceptors in the Gallia flow system.

1.3.5.2.3 Groundwater Flow

The main groundwater flow unit beneath the PORTS reservation is the Gallia aquifer formed by the Gallia sand and the Minford silt, with a combined average thickness of about 11 ft. The hydraulic conductivity of this aquifer is not considered as high, but the surrounding Cuyahoga shale and underlying Sunbury shale and Berea sandstone have even lower conductivities and form less important groundwater flow units (Reference 4). In general, the Gallia aquifer beneath the main plant area receives recharge through infiltration of rainfall and discharges water to surrounding low-lying areas through openings formed by missing Cuyahoga shale. One narrow opening is between the X-701B area and Little Beaver Creek to the east. Two wide openings exist, one near the northern perimeter road toward Little Beaver Creek and the other near the southern perimeter road. Discharges, in the form of groundwater, are likely to occur from the main plant area through these openings. Other openings that are not easily seen from the bedrock surface plot are associated with Big Run Creek to the south and the two unnamed tributaries to the west. Discharges through these openings are likely first in the form of groundwater and then as surface water in the creeks. All these discharge routes can be potential pathways for the site contaminants to reach areas outside the plant and ultimately the Scioto River.

Regional flow in the Berea is generally to the southeast, in the direction of structural dip. Locally, the flow direction is affected by Big Run Creek, Little Beaver Creek, and the west and southwest drainages (Reference 4). For example, flow in the northern part of the site turns somewhat northward due to the influence of Little Beaver Creek. In areas where the Sunbury is absent, the Berea and the overlying Gallia become hydraulically connected.

Groundwater flow directions in both aquifers are influenced by the presence of Little Beaver Creek, Big Run Creek, and the two unnamed tributaries. At many places, the two groundwater flow systems are roughly parallel, but at some places, for example near the northern perimeter road, they are quite different. In general, large head differences exist between the Gallia and the Berea because the Sunbury shale presents an effective barrier that restricts the vertical communication between the two aquifers (Reference 4).

Offsite monitoring of the sanitary water systems of local residents near the site began in 1979, and analysis for the presence of organic compounds was added in 1986 (Reference 4). The monitoring is conducted semiannually on springs and private wells near the site including parameters such as uranium, technetium, total alpha, and total beta. To date, the monitored parameters have not been detected above background levels in any of the sampling locations.

1.3.6 Geology and Seismology

1.3.6.1 Regional and Site Physiography

The PORTS reservation is located within the Interior Low Plateaus physiographic province, about 20 miles south of its northwestern edge. It is bordered on the north and west by the Central Lowlands province and on the south and east by the Appalachian Plateaus province. The Interior Low province is underlain by relatively flat-lying Paleozoic Age limestone and shale.

Portions of the Interior Low Plateaus province have been glaciated, but the site is south of the region covered by Pleistocene glaciation. However, alluvium and transported glacial sediments form a surface veneer in the mile-wide, broad valley where the site is located. The surrounding hills have been maturely dissected by erosion, exposing the underlying, nearly flat-lying shale and sandstone of Mississippian and Pennsylvanian Age.

The plant is located within a broad, flat valley that was (1) primarily developed by long-term erosion of the shale and sandstone that underlies the Interior Low Plateaus physiographic province; (2) subsequently modified by partial filling by glacial and alluvial sediments; and (3) later subjected to erosion. The prolonged erosion since the Permian Period has produced the dominant topography. Ground elevations within the plant generally range from about 660 ft MSL to 680 ft MSL, although the ground rises to about 700 ft MSL at the base of hills that border the Perimeter Road; the surrounding hills extend up to about 1,200 ft MSL. The nearby Scioto River (at about elevation 510 ft MSL) is the lowest elevation within five miles.

Prior to construction of the GDP, the area was farmland that formed a portion of the watershed for the nearby Scioto River. A drainage divide (about elevation 675 ft MSL) was at approximately midpoint of the plant, which separated gullies and streams flowing to the north from those flowing west and south. Generally, site preparation and grading performed approximately 50 years ago involved only minor surface modification. With the exception of a few drainage features (swales) that required as much as 20 ft of fill, most of the area developed was cut less than 10 ft and filled less than 12 ft.

1.3.6.2 Site Geology

Aside from roadways and other ancillary structures outside the Perimeter Road, the plant is located within the valley eroded into the bedrock by the ancient Portsmouth River and later filled in by glacial lake sediments. Except for a few low hills that extend into the plant site, the Perimeter Road on the west and east generally follows the lateral limits of the ancient Portsmouth River Valley. The valley is bounded on the west by a series of low hills extending up to elevation 840 ft MSL that have been maturely dissected; these hills expose nearly flat-lying Mississippian Age shales of the Sunbury and Cuyahoga Formations. The Sunbury and Cuyahoga Formations are also exposed in the maturely dissected low hills east of the plant site. These consolidated Mississippian formations dip downward to the east about 27 ft/mile (i.e., less than ½ a degree).

Drainage that developed at the site prior to glaciation consisted of a northward and westward flowing master stream (the ancient Teays River) and tributaries such as the ancient Portsmouth River. The Portsmouth River deposited a thin discontinuous veneer of alluvium in the site valley that has subsequently been covered by lacustrine deposits of glacial origin. Only the small streams that flow through the site contain recent alluvium.

Unconsolidated deposits at the site consist of Quaternary stream alluvium (Holocene and Pleistocene), Pleistocene lacustrine deposits of glacial origin, and older alluvium of the ancient Portsmouth River. Consolidated deposits within 500 ft of the ground surface consist of Devonian, Mississippian, and Pennsylvania shale and sandstone.

Unconsolidated material

Fill – Fill was placed during the 1950s to develop the site. Most of the fill ranges from 1 ft to 3 ft in thickness, but up to 20 ft of fill was placed in former stream valleys or draws to develop a plateau for building construction for the GDP facilities. Then in the early 1980s, additional fill was placed to create plateaus for the GCEP building construction. The fill is composed mostly of clean, silty clay. Verification data regarding fill density and its moisture content indicate that the fill under the plant buildings was compacted to at least 95 percent of its maximum dry density according to ASTM D 698 (standard Proctor).

Lacustrine deposits – Lacustrine deposits averaging 23 ft in thickness are exposed at the ground surface over much of the site and underlie fill at the remainder of the site; these deposits have been termed the Minford clays, Minford silts, or the Minford Clay Member of the Teays Formation. The general soil profile is composed of about 16 ft of clay underlain by about 7 ft of silt. Both these soil types are firm to very stiff, overconsolidated, and classified as silty clay and silt, but some highly plastic clay occurs near the ground surface.

Older alluvium – The lacustrine deposits are underlain by a discontinuous interval of clayey sand and gravel (Gallia sand) deposited by the ancient Portsmouth River. The alluvium is commonly referred to as the Gallia Sand Member of the Teays Foundation in the nearby Teays Valley. The average thickness is about 3 ft; the maximum thickness of the alluvium is 12 ft. It is firm to dense.

Consolidated material

Cuyahoga Formation – This Mississippian formation crops out in hills adjacent to the site, with the base of the formation at elevation 639 ft MSL. When unweathered, the Cuyahoga consists of about 339 ft thickness of hard grey to grey-green shale with lenses of sandstone.

Sunbury Formation – Underlying the Cuyahoga is a 19 to 20 ft thick interval of hard, black, carbonaceous shale. It underlies the unconsolidated sediments beneath most of the plant site.

Berea Formation – The Berea Formation underlies the Sunbury shale and extends downward. It is composed of about 30 to 35 ft of grey thick-bedded, fine-grained sandstone with shale laminations.

Bedford Formation – The Bedford is composed of about 98 ft of varicolored shale with interbeds of sandstone and siltstone.

Ohio Formation – The Ohio Shale is the uppermost Devonian Formation under the plant site. It is composed of 300 to 600 ft of dark brown, dark grey, and black fissile shale.

1.3.6.3 Site Structural Setting

Lacustrine deposits cover essentially all of the site bedrock; some streambeds contain recent alluvium. Little bedrock is exposed at the site except in the hills surrounding the plant. Neither the U. S. Army Corps of Engineers studies nor the Law Engineering Study in 1978 discovered evidence of bedrock faulting. The available data indicates that the underlying bedrock is not faulted; it has a strike of north 28° east and a homoclinical dip to the southeast of about 1/2 a degree.

1.3.6.4 Engineering Geology

The available evidence indicates the favorable performance of the PORTS facilities since their construction in the 1950s and the more recent GCEP facilities constructed in the early 1980s with respect to bearing capacity, settlement, and modest seismic events.

No shears, folds, or other structural weaknesses are known to be in the bedrock. Measurements of joint sets in bedrock exposed around plant site exhibit jointing typical of undeformed bedrock. These joints have no effect on the performance of foundations since they are covered by an interval of lacustrine glacial deposits. No evidence from the borings indicates zones of deep weathering that might indicate faulting or shearing.

No published data exist on unrelieved stresses in the bedrock, but the geologic history suggests that the bedrock may still be undergoing a very slow isostatic rebound. This rebound is due to a combination of the past loading and subsequent unloading of the bedrock by the Pleistocene glaciers and/or stress relief from erosion of the unconsolidated lacustrine sediments.

The consolidated bedrock within 500 ft of the ground surface is predominately clastic in origin (shale and sandstone).

Most of the unconsolidated soils are cohesive and overconsolidated and relatively uniform in thickness and extent. The soils exhibit a low potential for liquefaction and differential settlement. Cohesive soils exposed at the surface may exhibit minor shrinkage cracks resulting from moisture loss.

The geologic literature and records of mineral production in the site area indicate no mineral extraction has been done beneath the site. The potential exists for minor oil and gas accumulations in the underlying consolidated strata, but there are no records of significant gas or oil production within five miles of the site.

The soil at the site is primarily low plasticity clay and silty clay. The bedrock is composed of hard shale and sandstone.

The regional geologic history and extensive amount of exploratory data indicate no evidence of tectonic depressions, shears, faults, or folds.

The plant uses process water from the aquifer below the Scioto River, and no groundwater is withdrawn from the subsurface at the plant site for sanitary or process uses.

The exploratory and laboratory test data indicate that the glacial and alluvial soils are overconsolidated and have moisture contents well below their liquid limit. Engineering studies have shown the soils are only moderately compressible under applied foundation loads, and the satisfactory performance of the various foundations attests to that. The potential is low for surface fissuring of soils resulting from a period of extreme drought.

The studies by the U. S. Army Corps of Engineers and Law Engineering in the 1970s in the GCEP area, south-southeast and southwest of the GDP, found groundwater between 650 ft MSL and 665 ft MSL. The basal older alluvium exhibits no evidence of artesian conditions. Limited data on groundwater fluctuations indicate variations of between 3 ft and 5 ft over a period of six months. The groundwater level responds to annual precipitation.

No problems were encountered with groundwater during construction of the GCEP facilities. Most foundations bear upon the stiff lacustrine soils at depths of 5 ft or less below the finished floor elevation of the buildings.

No slopes within the Perimeter Road have inclination of 3 horizontal (H):1 vertical (V) or greater except for one slope; this slope is not adjacent to any structures (Reference 4). Low inclination slopes less than 20 ft in height that have soil parameters of $\phi = 10°$, c = 1,000 will have a static safety factor of at least 2.0 and a dynamic safety factor of at least 1.5 under a peak ground acceleration (PGA) of 0.21 gravity. The natural ground and engineered fill upon which the structures are founded have been analyzed for shear failure and settlement. Design documents show the factor of safety against shear failure under static conditions is more than 2.0, and predicted total settlements of foundations are less than 2 in. Because of the stiff nature of the foundation soils, negligible settlement will occur as a result of the design basis earthquake, as discussed in the next section.

1.3.6.5 Seismology

There are no major geologic fault structures in the vicinity of the site and there have been no historical earthquake epicenters within less than 25 miles from the site. However, there have been eight earthquake epicenters within 50 miles. The maximum event had an epicenter intensity of over IV on the Modified Mercalli (MM) scale. But all of these events were at the site with intensities between I and IV. The maximum PGA of a MM level IV event roughly corresponds to 0.02 gravity. Historically, the maximum earthquake-induced PGA experienced at the site was in 1955 and had a value of only 0.005 gravity.

In the Preliminary Safety Analysis Report developed for GCEP during the 1980s, the DOE documented the results of studies of the historic seismicity of the area surrounding the PORTS reservation. Data was developed on probable seismic activity and the intensity levels were converted into acceleration values. The maximum earthquake was defined as one with a mean recurrence interval of 1,000 years. This corresponds to an earthquake with a horizontal PGA of 0.15 gravity. Thus, the DOE considered that it was sufficient to design the structures, systems, and components necessary for safety to withstand this level earthquake without leading to undue risk to the health and safety of workers, the public or the environment. That is, the 1,000-year return earthquake was the design basis earthquake (DBE) for GCEP.

Several studies, including those mentioned above, have been conducted specifically for determining the seismic hazard for the GCEP site. One such study conducted by Beavers was involved in establishing the seismic design criteria for the GCEP. This criteria was published in a DOE document, ORO-EP-120 in 1978 and contained recommended design and maximum earthquake PGA values to be used in the design. The PGA values corresponding to these two earthquake levels were 0.04 gravity for the design earthquake and 0.15 gravity for the maximum earthquake corresponding to 72- and 1,000-year return periods, respectively. These PGA levels were selected based on judgement considering: (1) much of the information discussed in other former studies of the GDP site; (2) the GCEP was to be a newly constructed facility; (3) the GCEP might be subjected to licensing requirements; and (4) return periods of 1,000 years for events concerning safety were discussed for new enrichment plants. Although recommended, it was the opinion of the authors of ORO-EP-120 that the PGA value of 0.15 gravity for a return period of 1,000 years was on the conservative side. Therefore, the DBE for the Lead Cascade is the 1,000-year return earthquake.

1.3.6.6 Surface Faulting

The geologic setting of the site suggests there is a low probability of faulting within five miles of the site. No data from the three extensive geotechnical studies at the site (rock shearing, sharp changes in strata dip, and flexures) are characteristic of faulted rocks. The available data indicates the site bedrock is not faulted.

1.3.6.7 Liquefaction Potential

Three extensive exploration and laboratory testing programs (data sets) have been completed at the site, with the total number of approximately 960 exploratory borings. These borings and accompanying laboratory test results were used at the site to analyze the response of soil to ground shaking caused by earthquakes.

The laboratory classification tests, shear strength tests, and consolidation test data were used to define the general engineering characteristics of the soil. Analysis of the data indicates that there is a low potential for soil liquefaction at the site, even in the unlikely event of the occurrence of an earthquake of magnitude 5.25 with a maximum PGA of 0.15 gravity. Consequently, settlement in the site area due to liquefaction is unlikely.

Table 1.3-1
Historic and Projected Population in the Vicinity of the PORTS Reservation

	1980	1990	2000	2010
Jackson County	30,592	30,230	32,641	34,724
Pike County	22,802	24,249	27,695	29,981
Ross County	65,004	69,330	73,345	80,111
Scioto County	84,545	80,327	79,195	81,307
Region of Influence	202,943	204,136	212,876	226,123
Ohio	10,797,630	10,847,115	11,353,140	11,805,877

Year 2010 projections based on established rates applied to 2000 census counts.

(Reference 2)

Table 1.3-2
Precipitation as a Function of Recurrence Interval and Storm Duration for the PORTS Reservation

Recurrence Interval (years)	Storm duration (hours)						
	0.5	1	2	3	6	12	24
	Precipitation (in.[a])						
1	0.85	1.06	1.34	1.44	1.75	2.04	2.43
2	1.04	1.28	1.57	1.71	2.02	2.44	2.70
5	1.36	1.66	1.98	2.14	2.52	2.98	3.41
10	1.52	1.93	2.30	2.52	2.98	3.40	3.90
25	1.75	2.24	2.64	2.92	3.38	3.91	4.55
50	1.96	2.51	2.97	3.16	3.78	4.20	4.93
100	2.16	2.73	3.22	3.48	4.00	4.88	5.26
10,000[b]	3.46	4.45	5.15	5.57	6.42	7.49	8.32

a. 1 in. = 2.54 centimeters (cm)
b. Extrapolated values calculated using least-squares methodology.

(Reference 4)

Table 1.3-3
Comparison of Flood Elevations of the Scioto River near the PORTS Reservation with the Nominal Grade Elevation

	Elevation	
Recurrence interval	Meters (m)	Feet (ft)
50-year flood[a]	170.1	558.0
100-year flood[a]	170.8	560.3
500-year flood[a]	172.4	565.7
Historical written record[b]	169.7	556.7
Probable Maximum Flood[c]	174.0	571.0
PORTS nominal grade	204.2	670.0

a. Estimates by U.S. Army Corps of Engineers (Reference 4).
b. Estimated from records at Higby, 181.0 m (593.7 ft) (Reference 4), assuming the flood level at the mouth of Big Beaver Creek is 11.3 m (37 ft) lower.
c. Probable Maximum Flood (PMF) calculated flow is greater than that of the estimated 10,000-year flood discharge.

(Reference 4)

Table 1.3-4
Regional Stratigraphic and Hydrogeologic Subdivisions

ERA	System	Series	Formation or Unit	Hydrogeologic Unit
Cenozoic	Quaternary	Pleistocene	Teays Scioto River Outwash Minford Member Gallia Member	Scioto River
	Mississippian		Cuyahoga Sunbury Shale Berea Sandstone Bedford Shale	Gallia
Paleozoic	Devonian	Upper	Ohio Shale	Bedrock

(Reference 4)

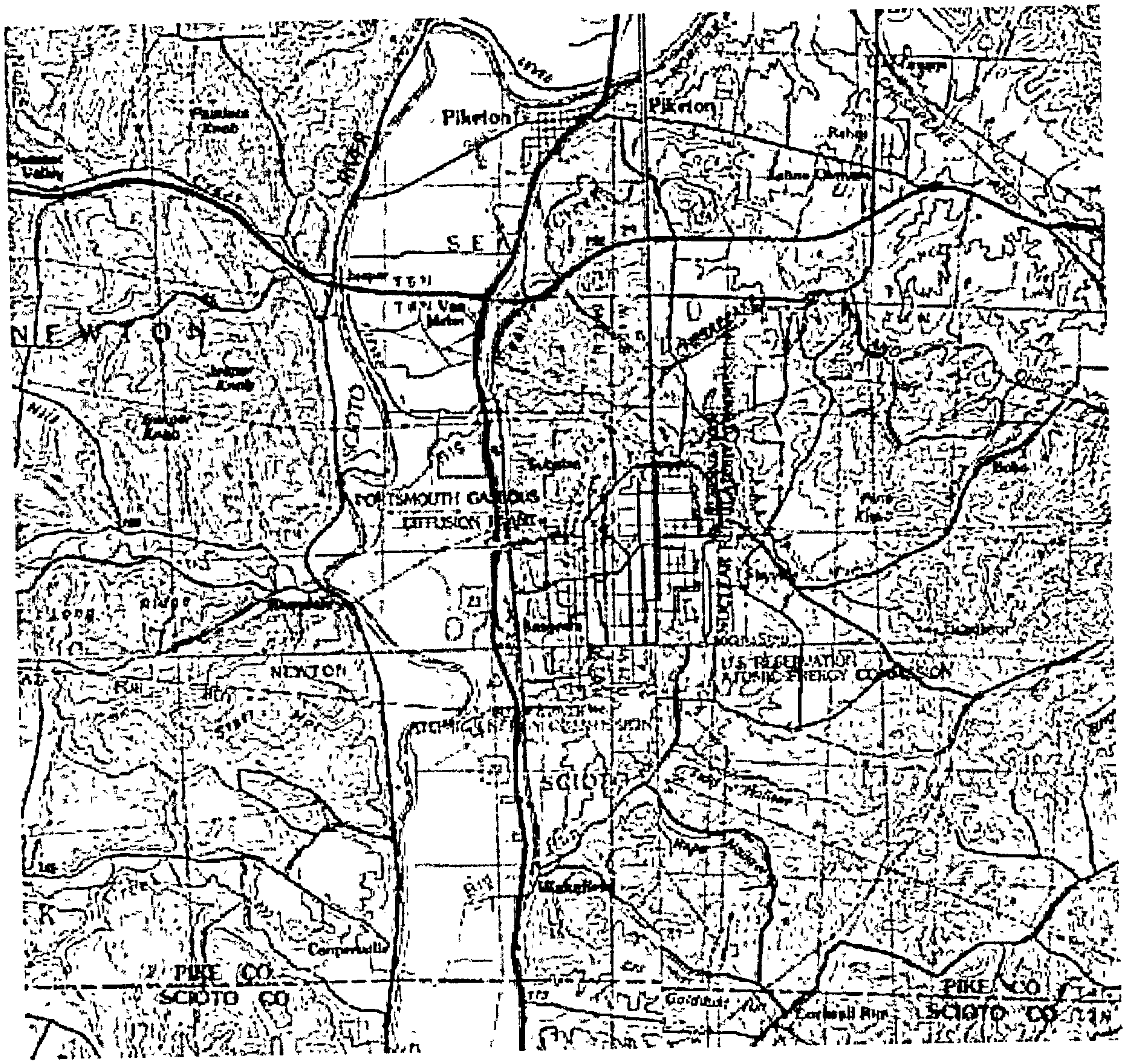

Figure 1.3-1
Topographic Map of the PORTS Site
(Reference 6)

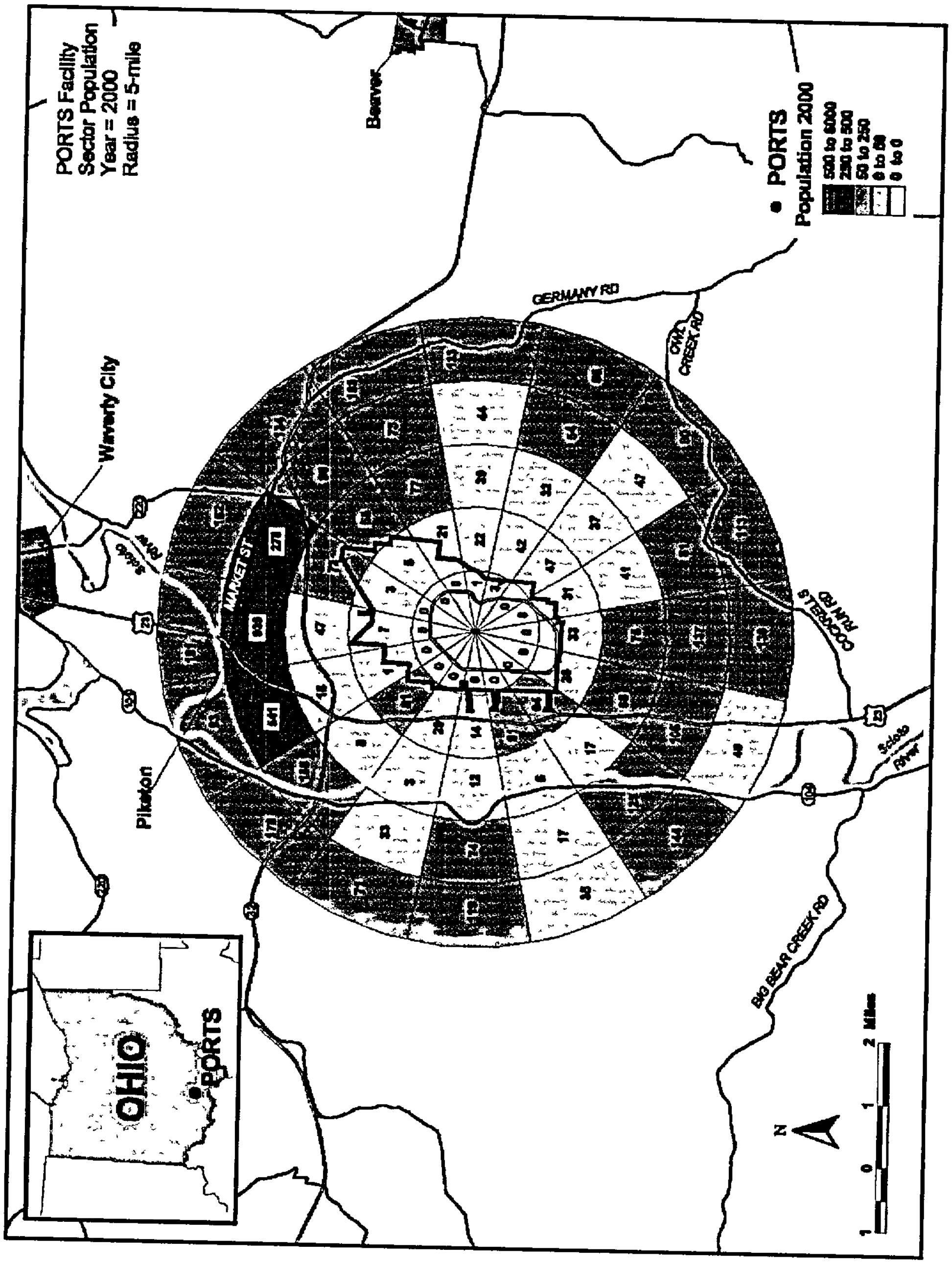

Figure 1.3-2
Population within 5-Mile Radius of PORTS
(Reference 7)

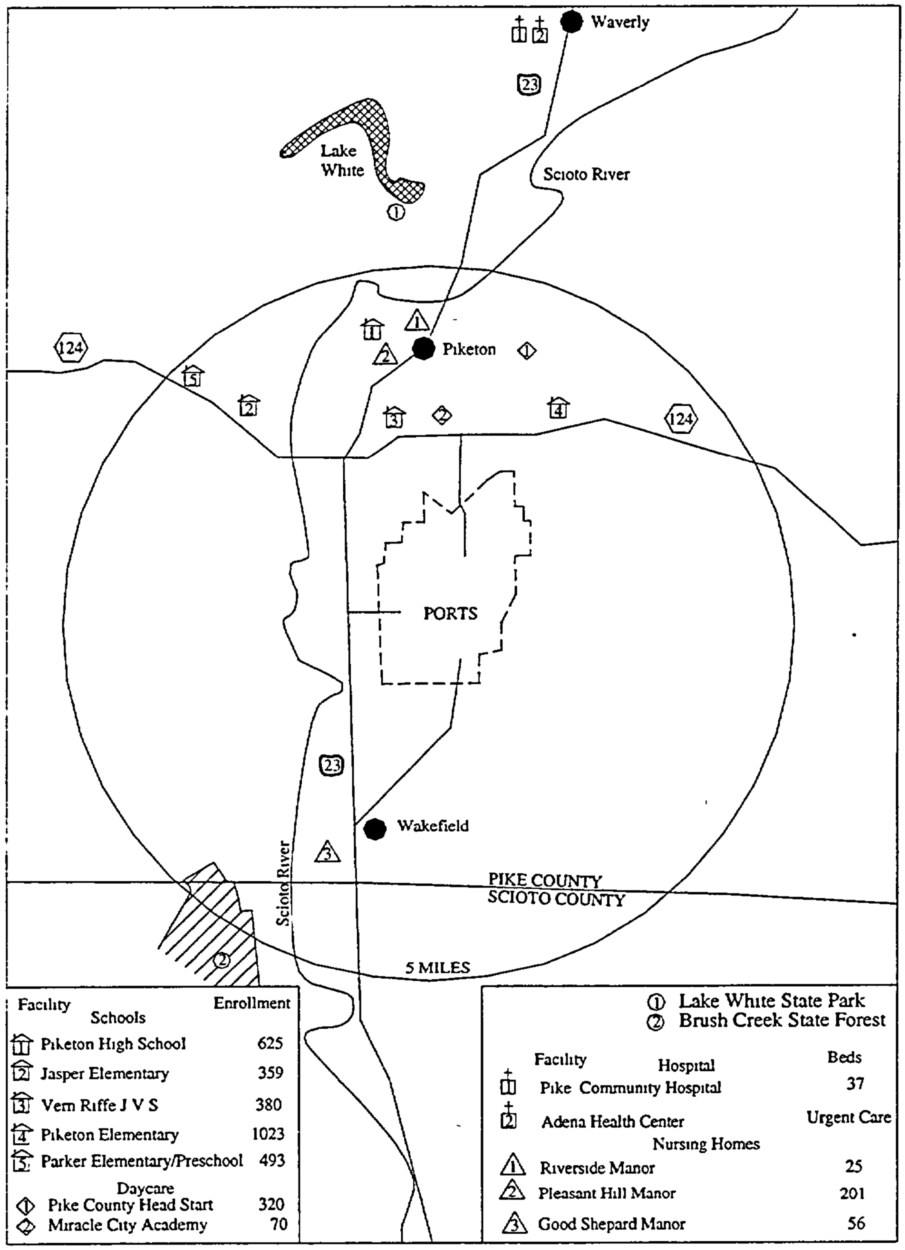

Figure 1.3-3
Special Population Centers within 5 miles of PORTS

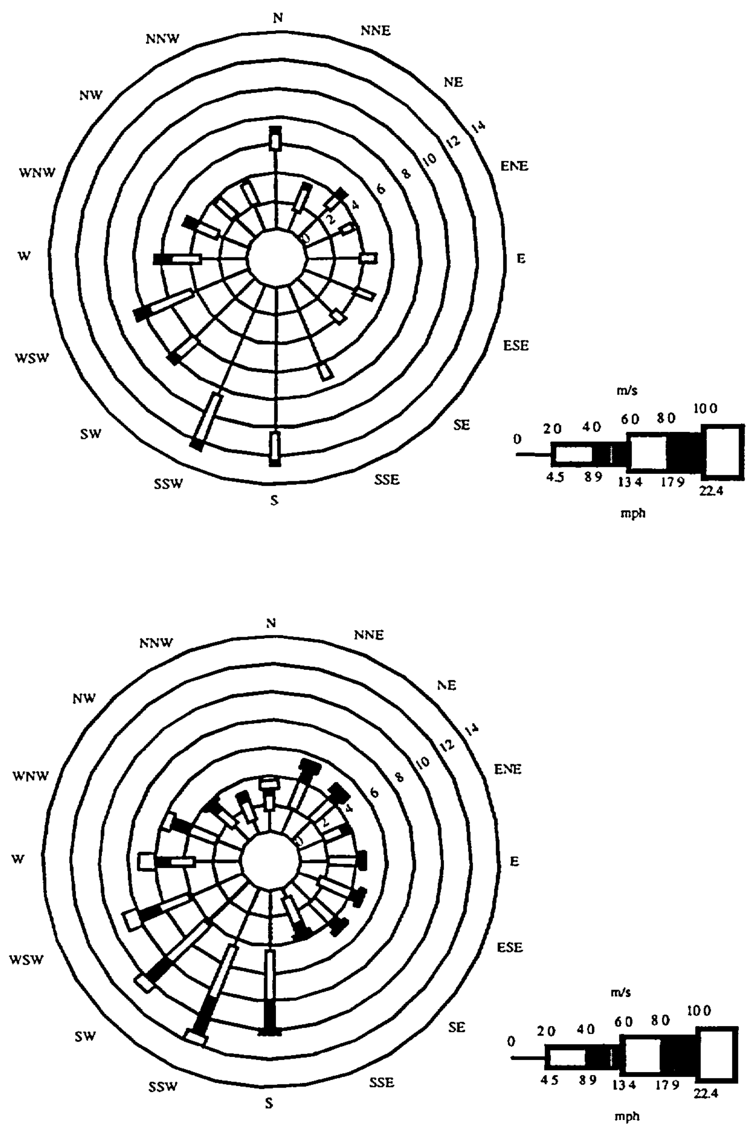

Figure 1.3-4
Comparison of wind roses at 10-m (top) and 32-m (bottom) levels at PORTS for 1993
(Reference 4)

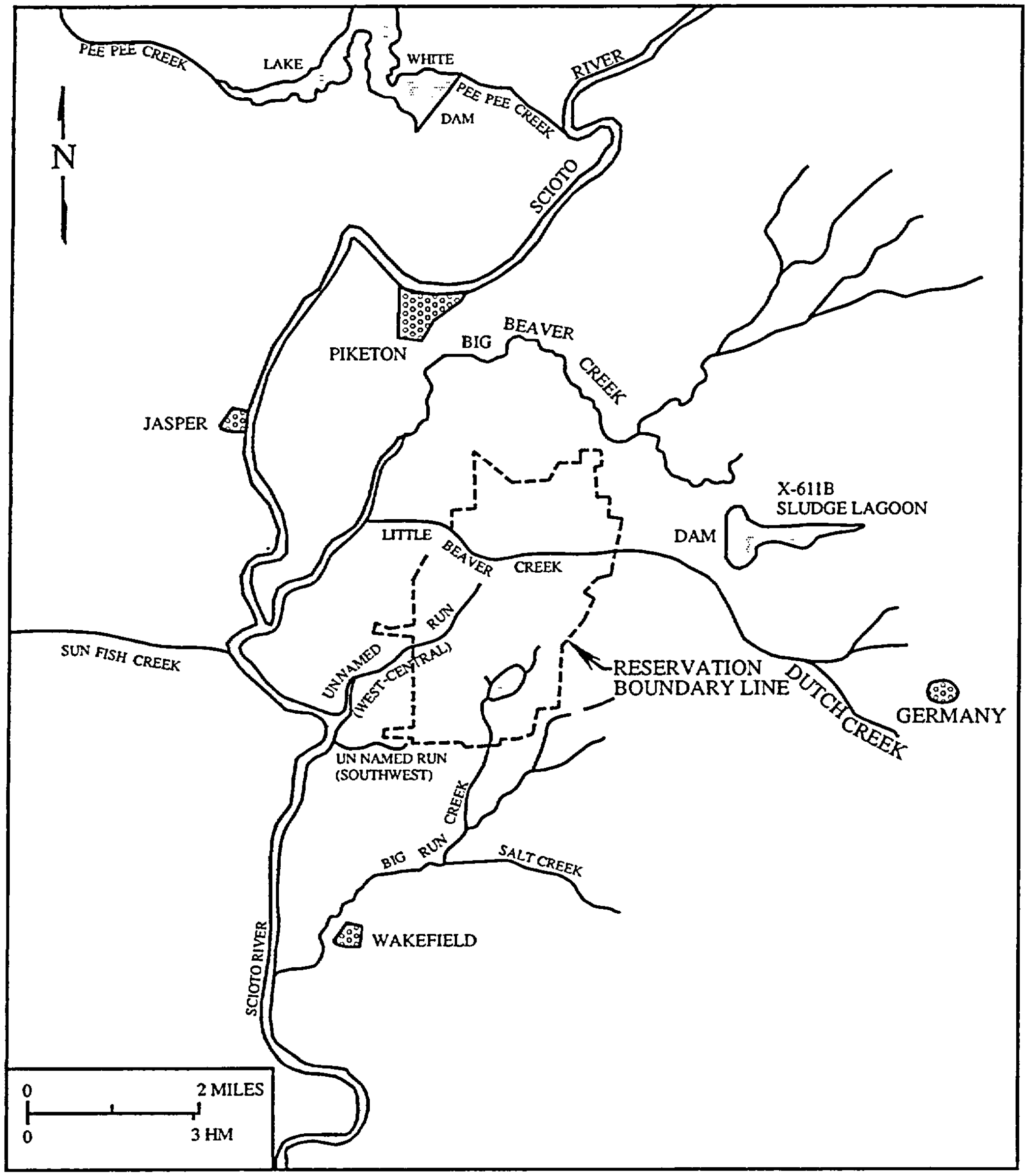

Figure 1.3-5
Location of Rivers and Creeks in the Vicinity of PORTS
(Reference 4)

This figure is withheld pursuant to 10 CFR 2.790 and is located in Appendix A of this license application

Figure 1.3-6
Ponds and Lagoons at PORTS
(Reference 4)

This figure is withheld pursuant to 10 CFR 2.790 and is located in Appendix A of this license application

Figure 1.3-7
Elevations of Roadways and of the Surrounding Areas of Main Process Buildings
(Reference 4)

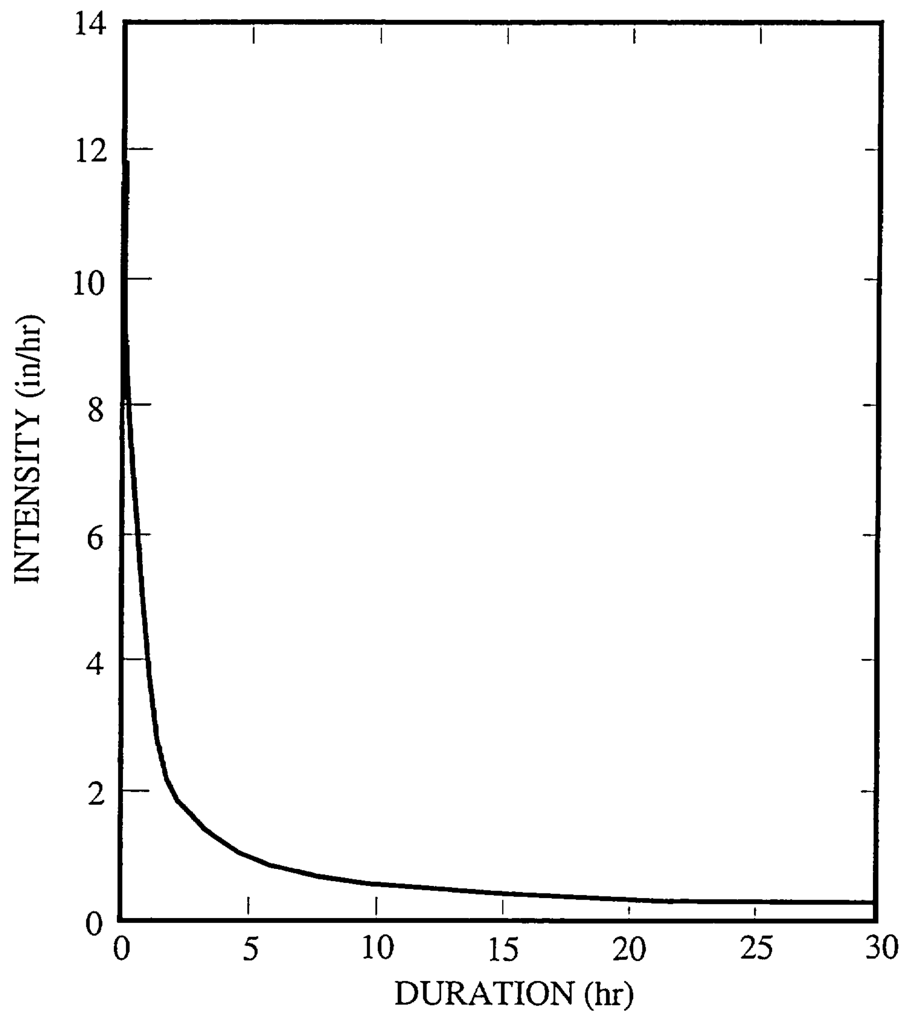

Figure 1.3-8
The 10,000-year Intensity Versus Duration Graph for PORTS
(Reference 4)

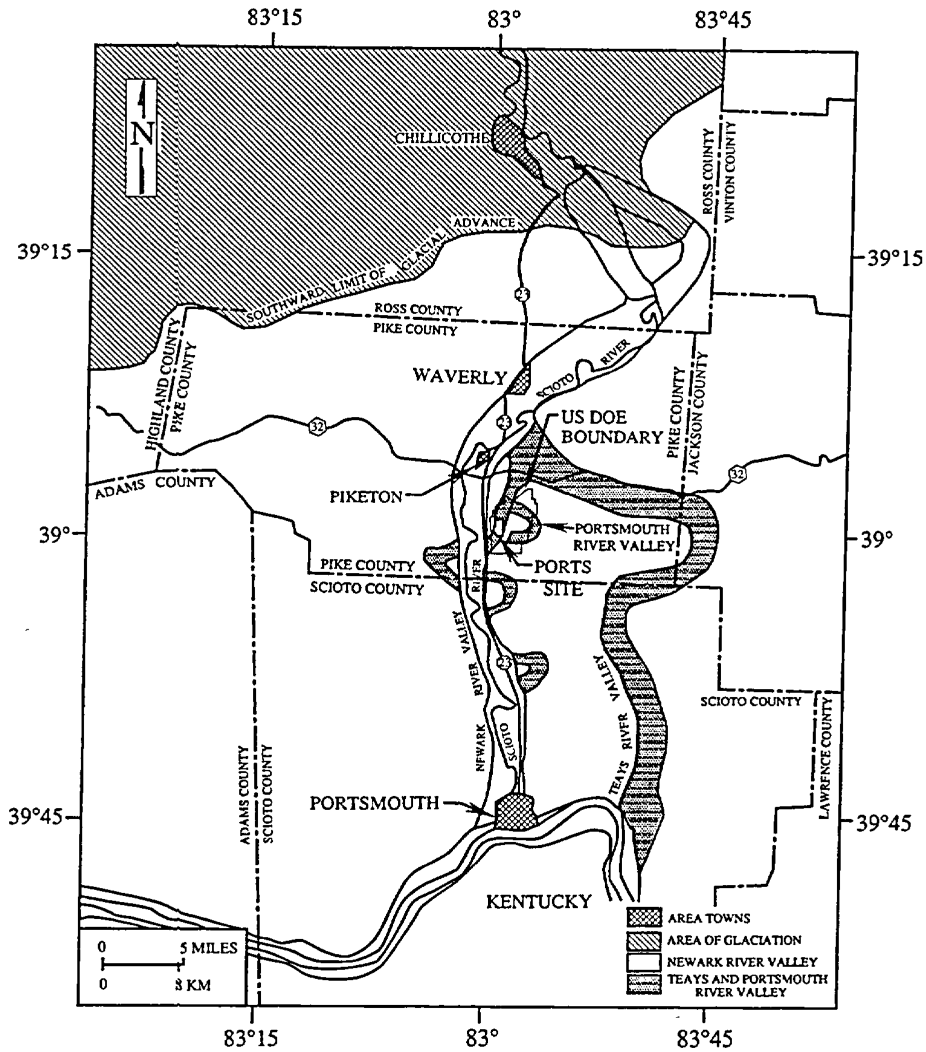

Figure 1.3-9
Location of the Ancient Newark (Modern Scioto) and Teays Valleys in the PORTS Vicinity
(Reference 4)

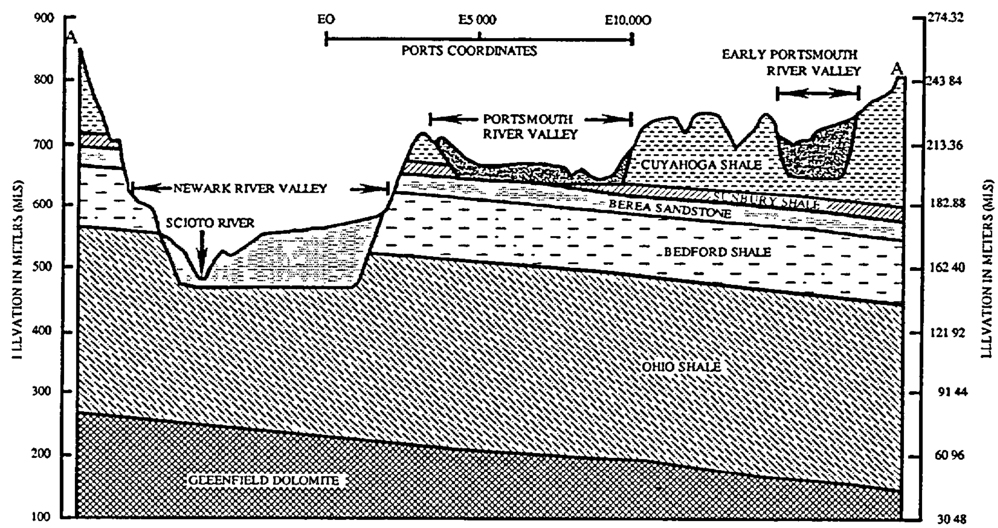

Figure 1.3-10
Geologic Cross Section in the PORTS Vicinity
(Reference 4)

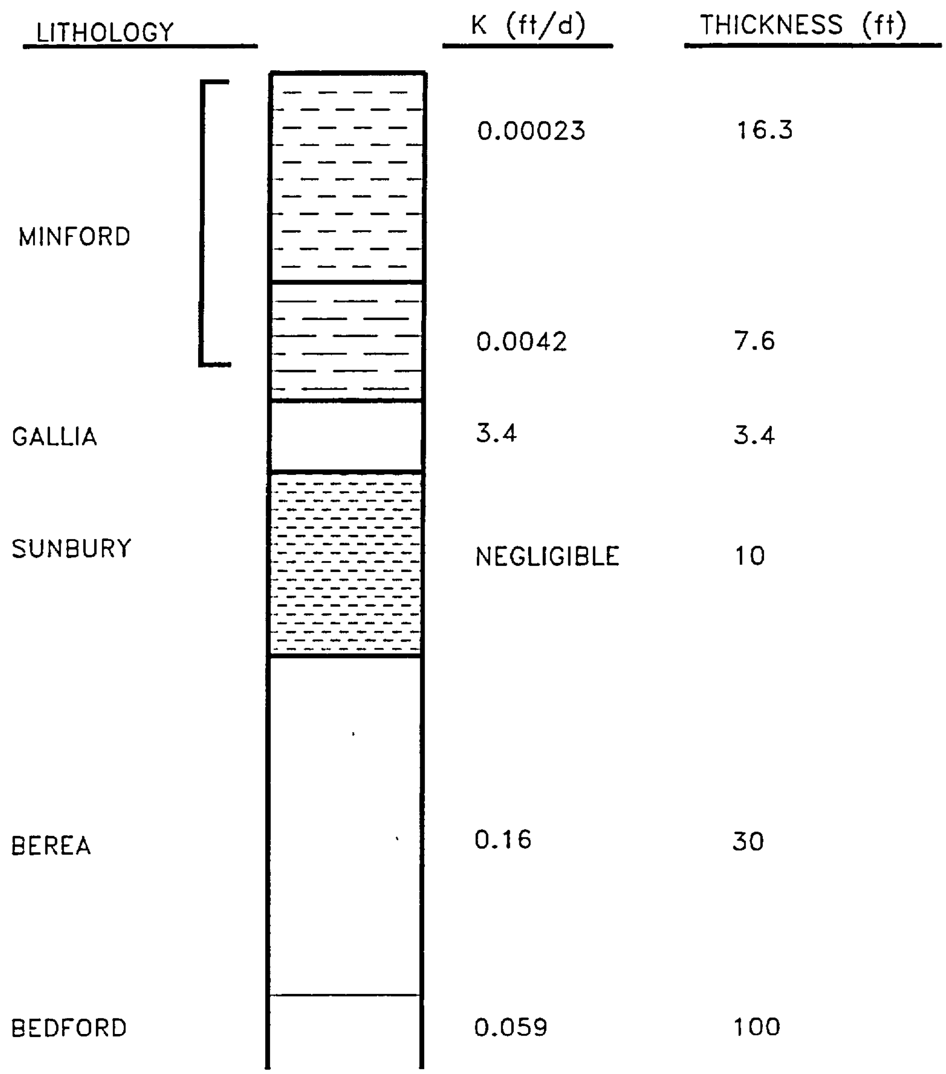

Figure 1.3-11
Geologic Column at PORTS
(Reference 4)

1.4 Applicable Codes, Standards, and Regulatory Guidance

The following lists the various industry codes, standards, and regulatory guidance documents that have been referenced in this license application. The extent to which USEC satisfies each code, standard, and guidance document is identified below:

1.4.1 American National Standards Institute/American National Society

- ANSI/ANS 3.2-1994, *Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants*

  USEC utilizes the provisions contained in Appendix A.6, paragraph (a) of this standard.

  For the reference to this standard see Section 11.4.4.1 of this license application.

- ANSI/ANS-8.1-1983, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactor*

  USEC satisfies the guidance of this standard with the following exceptions/clarification:

  > Section 4.1.6 - Operations are reviewed annually; however, this review is performed by personnel in the operating group who are knowledgeable of the NCS requirements for their operations. Personnel who are knowledgeable in NCS and are independent of operations (e.g., Engineering) provide assistance in these annual reviews. Personnel who are knowledgeable in NCS and are independent of operations (e.g., Engineering) review operations biannually (every two years).

  For references to this standard see Sections 5.4.1, 5.4.2, 5.4.5.1, and 5.4.5.2 of this license application.

- ANSI/ANS-8.19-1996, *Administrative Practices for Nuclear Criticality Safety*

  USEC satisfies the provisions of this standard with the following exceptions/clarification:

  > Section 7.8 - Operations are reviewed annually; however, this review is performed by personnel in the operating group who are knowledgeable of the NCS requirements for their operations. Personnel who are knowledgeable in NCS and are independent of operations (e.g., Engineering) provide assistance in these annual reviews. Personnel who are knowledgeable in NCS and are independent of operations (e.g., Engineering) review operations biannually (every two years).

  For references to this standard see Sections 5.4.1, and 11.3.13, of this license application.

- ANSI/ANS-8.20-1991, *American National Standard for Nuclear Criticality Safety Training*

  USEC satisfies the provisions of this standard.

  For references to this standard see Sections 11.3.4.2, 11.3.6, and 11.3.12 of this license application.

1.4.2 American National Standards Institute

- ANSI N323-1978, *Radiation Protection Instrumentation Test and Calibration*

  USEC satisfies the provisions of this standard, except for Sections 4.6 and 5.1(3).

For the reference to this standard see Section 4.8.4 of this license application.

1.4.3 American National Standards Institute/American Society of Mechanical Engineers

- ANSI/ASME NQA-1-1994, *Quality Assurance Requirements for Nuclear Facility Applications*

  USEC satisfies the provisions of this standard as stated below, with clarification stated in the QAPD:

  A. USEC satisfies the definitions, as stated in the Introduction of Part I of ASME NQA-1-1994.

  B. Indoctrination and training satisfies the provisions of Supplement 2S-4, "Supplementary Requirements for Personnel Indoctrination and Training" of Part 1 of ASME NQA-1-1994.

  C. Quality Control personnel performing inspection and testing satisfies the provisions of Supplement 2S-1, "Supplementary Requirements for the Qualification of Inspection and Test Personnel" of Part 1 of ASME NQA-1-1994.

  D. QA audit personnel satisfies the provisions of Supplement 2S-3, "Supplementary Requirements for the Qualification of Quality Assurance Program Audit Personnel" of Part 1 of ASME NQA-1-1994.

  E. Design outputs that consist of computer programs are developed, validated, and managed in accordance with ASME NQA-1-1994, Basic Requirement 3 and Supplement 3S-1, "Quality Assurance Requirements of Computer Software for Nuclear Facility Application."

F. Methods of design verification satisfies the provisions of Supplement 3S-1 of ASME NQA-1-1994.

G. Computer Program Testing is performed in accordance with ASME NQA-1-1994, Basic Requirement 11, "Test Control," and Supplement 11S-2, "Supplementary Requirements for Computer Program Testing."

H. Lifetime records are defined in accordance with ASME NQA-1-1994, Supplement 17S-1, "Supplementary Requirements for Quality Assurance Records," Section 2.7.1.

I. Hard copy or microfilm storage facilities satisfies the guidance of ASME NQA-1-1994, Supplement 17S-1, "Supplementary Requirements for Quality Assurance Records," Section 4.4.

For the references to this standard see Section 11.5.1 of this license application and Sections 2, 3, and 11 of the QAPD.

1.4.4 American Society of Mechanical Engineers

- ASME N509-1989, *Nuclear Power Plant Air-Cleaning Units and Components*

  New and existing fixed HEPA filter systems needed to ensure compliance with release limits or to control worker radiation exposure satisfy the provisions of this standard with the following exceptions/clarifications:

  Section 5.2 - Do not satisfy; No credit is taken for absorbers

  Section 5.5 - Do not satisfy requirements for air heaters

  Section 8.0 - Quality assurance requirements for applicable systems are identified in the QAPD

  Appendix A - Do not sample adsorbents

  Appendix B - Do not use allowable leakage guidance

  Appendix C – This appendix is used as guidance only

  Appendix D - The manifold qualification program uses this appendix as guidance only

  For the reference to this standard see Section 4.6.1 of this license application.

- ASME N510-1989, *Testing of Nuclear Air-Treatment Systems*

  New and existing fixed HEPA filter systems that satisfy the requirements of ASME N509 and are needed to ensure compliance with release limits or to control worker radiation exposure satisfy the provisions of this standard with the following exceptions/clarifications:

  Section 6.0 - Only satisfy this section for new seal-welded duct systems or for connections to a system where this section has been previously applied

  Section 7.0 - Do not use guidance for monitoring frame pressure leak tests

  Existing fixed HEPA filter systems that do not satisfy the requirements of ASME N509 are tested using the requirements of this standard or another industry accepted standard as guidance only

  For the reference to this standard see Section 4.6.1 of this license application.

1.4.5 National Fire Protection Association

- NFPA 10-1990, *Standard for Portable Fire Extinguishers*

  USEC satisfies the provisions of this standard with the following exceptions/clarification:

  The provisions of this standard were used as guidance only in determining the size, selection, and distribution of portable fire extinguishers. USEC will satisfy the provisions of this standard for modifications to the facility except as documented and justified by the Authority Having Jurisdiction (AHJ).

  For references to this standard see Sections 7.1.1, and 7.5.3 of this license application.

- NFPA 13-1989, *Standard for the Installation of Sprinkler Systems*

  USEC satisfies the provisions of this standard with the following exceptions/clarification:

  The provisions of this standard were used as guidance only for the design and installation of wet and dry pipe automatic sprinkler systems. In addition, the Process Building meets the definition of Ordinary Hazard Occupancies (Group 2) as stated in this standard and the fire protection system exceeds the sprinkler discharge of 0.15 gpm/sq ft for this type of occupancy. USEC will satisfy the provisions of this standard for modifications to the facility except as documented and justified by the AHJ.

For the reference to this standard see Section 7.1.1 of this license application.

- NFPA 15-1990, *Standard for Water Spray Fixed Systems for Fire Protection*

  USEC will satisfy the provisions of this standard for modifications to the facility except as documented and justified by the AHJ.

  For the reference to this standard see Section 7.1.1 of this license application.

- NFPA 24-1992, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*

  USEC satisfies the provisions of this standard with the following exceptions/clarification:

  > Underground piping for the high-pressure fire water system was installed and is maintained using the provisions of this standard for guidance only. USEC will satisfy the provisions of this standard for modifications to the facility except as documented and justified by the AHJ.

  For the reference to this standard see Section 7.1.1 of this license application.

- NFPA 30-1990, *Flammable and Combustible Liquids Code*

  USEC satisfies the requirements of this standard with the following exceptions/clarification:

  > Above ground storage tanks were installed using the provisions of this standard for guidance only. USEC will satisfy the provisions of this standard for modifications to the facility except as documented and justified by the AHJ.

  For references to this standard see Sections 7.1.1, and 7.3 of this license application.

- NFPA 72, *National Fire Alarm Code*

  This NFPA standard was used as guidance for the installation of the system.

  For the reference to this standard see Section 7.3.4 of this license application.

- NFPA 101-1991, *Code for Safety to Life from Fire in Buildings and Structures*

  USEC uses the provisions of this standard as guidance for the review of emergency egress paths.

  For the reference to this standard see Section 7.2.3 of this license application.

- NFPA 232-1986 (and 232 AM), *Standard for the Protection of Records*

  USEC satisfies the provisions of this standard with the following exceptions/clarification:

  > As described in Section 11.7.1.8 of the licensing application, there are several acceptable methods for the storage of permanent records. If the NFPA 232 (or 232 AM) method of storage in 2-hour-rated containers is used, any exceptions to this standard will be documented and justified by the AHJ.

  For the reference to this standard see Section 11.7.1.8 of this license application.

- NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Material*

  USEC will utilize this standard for any future modifications to the fire protection program as stated in Section 7.1.1 of the license application.

  For the reference to this standard see Section 7.1.1 of this license application.

1.4.6 Nuclear Regulatory Commission Guidance

- Regulatory Guide 1.59, Revision 2, *Design Basis Floods for Nuclear Power Plants*

  USEC satisfies the provisions of this Regulatory Guide (RG) to the extent applicable to a Part 70 licensee.

  For references to this standard see Sections 1.3.4.3 and 1.3.4.3.2 of this license application.

- Regulatory Guide 3.67, Revision 0, *Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities*

  USEC utilized the provisions of this RG as guidance for PORTS Emergency Plan.

  For references to this RG see Section 8.1, and 8.2 of this license application.

- Regulatory Guide 3.71, Revision 0, *Nuclear Criticality Safety Standards for Fuels and Material Facilities*

  This RG endorses ANSI/ANS-8 standards. USEC commits to ANSI/ANS-8.1-1983, ANSI/ANS-8.19-1996, and ANSI/ANS-8.20-1991 as described above.

  For the reference to this RG see Section 5.5 of this license application.

- Regulatory Guide 8.13, Revision 2, *Instructions Concerning Prenatal Radiation Exposure*

  USEC satisfies the provisions of this RG.

  For the reference to this RG see Section 4.1.1 of this license application.

- Regulatory Guide 1.109, Revision 1, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I*

  USEC satisfies the provisions of this RG to the extent applicable to Part 70 licensee.

  For references to this RG see Sections 9.2.2.1.2, and 9.2.2.2.2 of this license application.

- Regulatory Guide 1.159, Revision 0, *Assuring the Availability of Funds for Decommissioning Nuclear Reactors*

  This RG was used as a general reference and guidance document during development of this license application.

  For the reference to this RG see Section 10.10.1 of this license application.

- NUREG-1513, *Integrated Safety Analysis Guidance Document*

  This NUREG was used as a general reference and guidance document during the development of the Integrated Safety Analysis (ISA) and ISA Summary

  For references to this NUREG see Sections 3.1.2, 3.2, 3.3, 5.5, 6.14, 7.2.2, 7.6, 8.2, 9.2.3, and 9.4 of this license application.

- NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*

  This NUREG was used as a general reference and guidance document during the development of the license application. This license application follows the format and guidelines of the NUREG.

  For references to this NUREG see Sections 1.0, 1.4, 3.2, 5.5, 6.14, 7.6, 8.2, 9.2.3, 9.4, 10.11, and 11.9 of this license application.

- NUREG-1601, *Chemical Process Safety at Fuel Cycle Facilities*

  This NUREG was used as a general reference and guidance document during the development of the license application.

  For the references to this NUREG see Section 6.14 of this license application.

- NUREG/CR-6410, *Nuclear Fuel Cycle Facility Accident Analysis Handbook*

  Portions of this NUREG were used as a general reference and guidance document in the development of the accident analyses in the ISA.

  For the reference to this NUREG see Section 3.3 of this license application.

- NRC Information Notice No. 88-100: *Memorandum of Understanding between NRC and OSHA Relating to NRC-Licensed Facilities (53 FR 43950, October 31, 1988)*, December 23, 1988

  USEC has reviewed the information contained in this Information Notice.

  For the reference to this IN see Section 6.14 of this license application.

1.4.7 Other Codes, Standards, and Guidance

- Federal Guidance Report No. 11, "*Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*

  USEC satisfies the provisions of this guidance document.

  For the reference to this guidance document see Section 4.7.4 of this license application.

- American Society for Nondestructive Testing Recommended Practice No. SNT-TC-1A, June 1980 Edition

  USEC satisfies the provisions of this recommended practice.

  For the reference to this recommended practice see Section 2 of the QAPD.

1.5 References

1. USEC 2002 Annual Report

2. U.S. Bureau of the Census, 2000, "Profiles of General Demographic Characteristics: 2000 Census of Population and Housing, Ohio", U.S. Department of Commerce, May 2001, Website: http://www.census.gov/prod/cen2000/dp1/2kh39.pdf

3. USEC-PORTS, 2002, USEC Inc. correspondence entitled "Environmental Impact Study," September 30, 2002

4. USEC-02, Application for United States Nuclear Regulatory Commission Certification, Portsmouth Gaseous Diffusion Plant, Safety Analysis Report

5. Ohio Department of Natural Resources, Website accessed October 21, 2002, http://www.dnr.state.oh.us/parks/parks/lkwhite.htm

6. U.S. Department of the Interior, U.S. Geological Survey, Reston, VA, Website: http://www.usgs.gov/index.html

7. Tetra Tech, Inc. correspondence, "Methodology for the 5-mile Population Grids," November 2002

8. CDR-2000-0001, Lead Cascade Conceptual Design Report, Revision 0, January 13, 2003

9. Lead Cascade Security Program, AET 02-0004, Steven A. Toelle letter to Mr. Martin J. Virgilio, dated July 3, 2002

10. NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*

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2.0 ORGANIZATION AND ADMINISTRATION

USEC Inc. (USEC) is committed to conducting operations at the Lead Cascade in a manner that protects the health and safety of workers and the public, protects the environment, and provides for the common defense and security. In order to meet these commitments, as well as others required for operation of the Lead Cascade, USEC maintains the following operations policy with respect to environmental, health, nuclear safety, safeguards, security, and quality to guide the day-to-day business activities of, and provide direction to, Lead Cascade personnel.

> USEC is responsible for safe operation of the Lead Cascade and is committed to conducting operations in a manner that protects the health and safety of workers and the public, protects the environment, provides for the common defense and security, and is in compliance with applicable local, state, and federal laws and regulations.

USEC has provided the management structure to ensure that this policy is effectively implemented. The operations organization is responsible for the safe operation of the Lead Cascade. Programs and staff organizations are established for the environmental, health, safety, safeguards, security, and quality areas and are provided with sufficient resources to support safe operation of the Lead Cascade. Resources from the United States Enrichment Corporation (Corporation) at the Portsmouth Gaseous Diffusion Plant (PORTS) are utilized in a number of these programmatic areas to provide day-to-day functional support. Inter-company arrangements are in place with the Corporation to provide the necessary support. To the extent that USEC relies on existing programs and resources from PORTS, such programs and resources meet 10 *Code of Federal Regulations* Part 70 requirements.

USEC is responsible for the design, quality assurance, refurbishment, testing, start-up, and operation of the Lead Cascade. Preparation of some refurbishment documents and portions of the refurbishment itself are contracted to a qualified contractor. The Engineering Manager has the responsibility for construction management and coordination with the contractor.

USEC has direct responsibility for pre-operational testing, initial start-up, operation, and maintenance of the facility. USEC staffs the Lead Cascade with qualified individuals to ensure a smooth transition from refurbishment activities to facility operations.

Managerial positions that have the principal responsibilities important to environmental, health, safety, safeguards, security, and quality for the Lead Cascade are described in this chapter. Their qualifications, responsibilities, and authorities are clearly defined in position descriptions that are accessible to affected personnel and the U.S. Nuclear Regulatory Commission (NRC) upon request.

Section 2.1 describes the organizational commitments, relationships, responsibilities, and authorities for the overall management system to assure the protection of the health and safety of the workers and the public, protection of the environment, and provide for the common defense and security. This section includes the qualifications, functions, responsibilities, and authorities of the positions in the organizations assigned functions related to environmental, health, safety, safeguards, security, and quality during all stages of the project, from design through refurbishment, start-up, and operation.

Section 2.2 describes the management controls for maintaining the environmental, health, safety, safeguards, and quality programs and the administrative systems to control relationships and interfaces between programs.

Section 2.3 describes USEC's plans and the management controls for pre-operational testing and initial start-up of the Lead Cascade.

2.1 Organizational Commitments, Relationships, Responsibilities, and Authorities

The Lead Cascade management structure provides for line responsibility for safe operations with sufficient staff support to develop, communicate, and implement technical programs for various environmental, health, safety, safeguards, security, and quality areas.

Figure 2.1-1 shows the Lead Cascade organization for the design/refurbishment/start-up phase of the facility. Prior to beginning operations, this organization transitions to the one shown in Figure 2.1-2, for the safe operation of the Lead Cascade.

The Lead Cascade Manager provides overall direction and management of Lead Cascade operations, and oversees activities to ensure safe and reliable operations. The Regulatory Manager, Engineering Manager, Project Support Manager, Operations and Maintenance Manager, Quality Services Manager, and Training Manager report to the Lead Cascade Manager and manage the activities in their area of responsibility.

Day-to-day functional support for carrying out the requirements of the environmental, safety, health, safeguards, and security programs is provided by the Corporation, along with administrative services required to support overall facility operations. A description of the Corporation's gaseous diffusion plant (GDP) management structure and associated responsibilities is described in Reference 4. Services provided by the Corporation include those listed in Table 2.1-1. Table 2.1-1 identifies which Lead Cascade manager has decision making authority and responsibility for oversight of the major functional support areas provided by the Corporation. The Corporation also provides the necessary utilities (e.g., electricity, compressed air, cooling water, potable water, and sanitary sewage) to support operation of the Lead Cascade.

Personnel minimum qualifications, functions and responsibilities for key staff positions are described below. The personnel responsible for managing the design, refurbishment, and operation of the facility have substantive breadth and level of experience in their areas of expertise to successfully execute their responsibilities. They are located at the facility and are available during normal day-shift hours. Alternates are designated in writing in accordance with procedural requirements to fulfill the responsibilities and authorities of these personnel during their absence from the facility.

Throughout this section, equivalent technical experience means the substitution of two years of nuclear industry experience for each year of college up to a total of three years. Additionally, 30 semester hours or 45-quarter hours from an accredited college or university may be substituted for the remaining one year of baccalaureate education. Individuals who do not possess the formal educational requirements specified in this section or do not meet the equivalent technical experience defined above are not automatically eliminated where other factors provide sufficient demonstration of their abilities to fulfill the duties of a specific position. These other factors must clearly demonstrate proficiency in the technical area for which the position will be responsible, for example, a license or certification, documented completion of relevant training, or previous experience in the same position at another facility. These factors are evaluated on a case-by-case basis, documented, and approved by the Lead Cascade Manager.

2.1.1 Executive Vice President and Chief Operating Officer

The Executive Vice President and Chief Operating Officer reports to the President and Chief Executive Officer. The Executive Vice President and Chief Operating Officer has overall responsibility for safe operation of the Lead Cascade and has shutdown and stop work authority for all portions of the Lead Cascade facilities. If such authority is exercised, the Executive Vice President and Chief Operating Officer must concur with restart of shutdown operations.

The Executive Vice President and Chief Operating Officer has as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, six years nuclear experience, and ten years of management experience (which may be concurrent with the nuclear experience).

The USEC Board of Directors appoints the Executive Vice President and Chief Operating Officer.

2.1.2 Vice President, Operations

The Vice President, Operations reports to the Executive Vice President and Chief Operating Officer. The Vice President, Operations is responsible for the Quality Assurance Program and for determining, the status, adequacy, and effectiveness of the Quality Assurance Program Description (QAPD).

The Vice President, Operations has as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, 6 years nuclear experience, and 10 years management experience (which may be concurrent with the nuclear experience).

2.1.3 Director, Enrichment Technology

The Director, Enrichment Technology reports to the Executive Vice President and Chief Operating Officer and has responsibility for program management of Advanced Enrichment Projects including process development, engineering, business and strategic planning, and deployment management.

The Director, Enrichment Technology has shut down and stop work authority for all portions of the Lead Cascade facilities, and if such authority is exercised, must concur with restart of shutdown operations.

The Director, Enrichment Technology has as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, and six years of experience in engineering, production, and project management, in the nuclear industry.

The Director, Enrichment Technology is appointed by the Executive Vice President and Chief Operating Officer.

2.1.4 Lead Cascade Manager

The Lead Cascade Manager reports to the Director, Enrichment Technology.

The Lead Cascade Manager is responsible for the day-to-day safe operation of the facility, for compliance with all applicable NRC regulatory requirements, and for adherence to applicable policies. The Lead Cascade Manager is responsible for overall safe operation and maintenance of the Lead Cascade facilities, including assembly, operation, testing, and sampling. The position is responsible for training, procedures, engineering, and occupational, environmental, and nuclear safety. The Lead Cascade Manager also has responsibility for the primary routine interface with the NRC on matters of adequate safety/safeguards and regulatory compliance, and may delegate responsibility for this interface to the Regulatory Manager.

The Lead Cascade Manager has shut down and stop work authority for all portions of the Lead Cascade leased facilities, and if such authority is exercised, must concur with restart of shutdown operations. The Lead Cascade Manager must obtain concurrence of the Director, Enrichment Technology for restart of any operations that were directed to be shut down by the Director, Enrichment Technology, the Nuclear Safety and Quality (NS&Q) Manager, or the Quality Services Manager.

The Lead Cascade Manager has as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, six years of nuclear experience, and six years of management experience (which may be concurrent with the nuclear experience).

The Director, Enrichment Technology, appoints the Lead Cascade Manager.

2.1.5 Regulatory Manager

The Regulatory Manager reports to the Lead Cascade Manager.

The Regulatory Manager is responsible for oversight functions in environmental, health, and safety areas. These include the radiation protection/industrial hygiene program, waste management and environmental compliance, and industrial safety. The Regulatory Manager is also responsible for the environmental monitoring program described in Section 9.2, the Lead

Cascade environmental protection programs, the industrial and chemical safety programs, and the radiation protection (RP) program for the Lead Cascade. This manager appoints a Lead Cascade program manager for the Chemical Safety Program.

The Regulatory Manager is responsible for the safeguards and security programs for the Lead Cascade. The Regulatory Manager, as delegated by the Lead Cascade Manager, maintains the day-to-day interface with NRC representatives on matters of regulatory compliance. The individual has responsibility for managing the facility change process and ensuring the facility change reporting requirements are met. The Regulatory Manager is also responsible for implementing the Corrective Action Program, ensuring event investigations are performed, and providing Lead Cascade management with data to assure that corrective actions and commitments are properly addressed and managed to facilitate compliance with implementing policies and procedures.

In the absence of the Lead Cascade Manager, the Regulatory Manager may be delegated the responsibilities and authorities of the Lead Cascade Manager. This manager has the authority to stop work and/or shut down operations in any part of the Lead Cascade where activities are not being conducted in accordance with applicable regulatory requirements. If such authority is exercised, the Regulatory Manager must concur with restart of shutdown operations.

The Regulatory Manager has as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, and four years of nuclear experience.

The Lead Cascade Manager appoints the Regulatory Manager with concurrence from the Director, Enrichment Technology.

2.1.6 Radiation Protection Manager (PORTS)

The Regulatory Manager is responsible for the RP Program for the Lead Cascade. The Corporation's Radiation Protection Manager (RPM) is responsible for providing guidance and direction for establishment and implementation of the RP Program to the Regulatory Manager and has the authority to deny access to radiological areas for personnel who do not adhere to radiological protection requirements. The RPM has oversight of all radiological protection procedures with the authority to oversee, stop work, or subcontract the services, as necessary, to maintain the integrity of the RP Program. The RPM has direct access to the Lead Cascade Manager and the Director, Enrichment Technology for radiation protection matters, and has stop work authority for activities not being conducted in accordance with radiation protection requirements and policies. If such authority is exercised, the RPM must concur with restart of shutdown operations. The RPM's responsibilities for the Lead Cascade are consistent with those exercised at PORTS.

The RPM has as a minimum a bachelors degree in engineering, health physics, radiation protection, or the physical sciences or equivalent technical experience, and four years experience in radiation protection, including six months at a uranium processing facility.

2.1.7 Operations and Maintenance Manager

The Operations and Maintenance Manager reports to the Lead Cascade Manager.

The Operations and Maintenance Manager is responsible for the assembly of centrifuge machines, transportation of machines to and from the cascade, and operation of equipment in the Lead Cascade facilities. This includes activities such as ensuring the correct and safe operation of the uranium hexafluoride (UF_6) processes; proper receipt, storage, handling, and onsite transportation of UF_6; and providing chemical cleaning and decontamination services. The Operations and Maintenance Manager is also responsible for integrated planning and scheduling. This includes managing daily work control activities, developing an integrated work schedule, and coordinating development of work control guidelines. Operational analysis of the Lead Cascade performance is also the responsibility of the Operations and Maintenance Manager. During the start-up phase of the Lead Cascade, the Operations and Maintenance Manager is responsible for individual centrifuge machine testing and integrated system testing.

The Operations and Maintenance Manager is responsible for safe and reliable performance of preventive, predictive, and corrective maintenance and support services on Lead Cascade facilities and equipment. This includes troubleshooting, maintenance of logs and records, work planning/control to initiate, screen, evaluate, and prioritize maintenance work, and coordinating shop maintenance.

In the absence of the Lead Cascade Manager, the Operations and Maintenance Manager may be delegated the responsibilities and authorities of the Lead Cascade Manager. This manager has the authority to stop work and/or shut down operations in any part of the operation for which he/she has responsibility. If such authority is exercised, the Operations and Maintenance Manager must concur with restart of shutdown operations.

The Operations and Maintenance Manager has as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, and four years of nuclear experience.

The Operations and Maintenance Manager is appointed by the Lead Cascade Manager, with concurrence from the Director, Enrichment Technology.

2.1.8 Operations and Maintenance Supervisors

Operations and maintenance supervisors report to the Operations and Maintenance Manager.

Operations supervisors are titled Lead Cascade Shift Supervisor. They authorize the restart of equipment that has been shutdown in a routine fashion when the prerequisites and limitations of the associated operating procedure are met. The Lead Cascade Shift Supervisor is responsible for providing operational support of centrifuge machine assembly, transport, installation, pump down, integrated system testing, start-up, operation, and repair. The Lead

Cascade Shift Supervisor also directs the operation of systems within the Lead Cascade facilities, necessary to support Lead Cascade operation.

Maintenance supervisors are titled Lead Cascade Maintenance Supervisor. They supervise maintenance of electrical equipment, electronic and pneumatic instrumentation and controls, and computers and programmable controllers. The Lead Cascade Maintenance Supervisor is also responsible for supervising mechanical maintenance, such as valve, pump, and mechanical repair and replacement. In addition, this supervisor is responsible for supervising other maintenance, such as painting, carpentry, sheet metal and machinist activities.

Operations and maintenance supervisors have as a minimum a high school diploma or satisfactory completion of the General Educational Development test, and three years of industrial/chemical/nuclear plant operations, maintenance, or engineering experience. Supervisors must have one-year supervisory experience or completion of a supervisory training course.

The Operations and Maintenance Manager appoint operations and maintenance supervisors.

2.1.9 Engineering Manager

The Engineering Manager reports to the Lead Cascade Manager.

The Engineering Manager is responsible for engineering activities in support of operations, including procurement engineering, configuration management, projects (design, fabrication, and construction of facility modifications or additions), system engineering, and business management. The Engineering Manager manages the design change process for the facility. During the refurbishment/start-up phase of the Lead Cascade, the Engineering Manager is also responsible for project and construction management, as well as providing the primary interface with the refurbishment contractor.

The Engineering Manager is responsible for the Nuclear Criticality Safety (NCS) program and maintaining the Integrated Safety Analysis (ISA) and ISA Summary for the facility.

In the absence of the Lead Cascade Manager, the Engineering Manager may be delegated the responsibilities and authorities of the Lead Cascade Manager. The Engineering Manager has stop work authority for any activity that poses a nuclear safety or criticality concern, or any activity that would be or is in violation of the facility's licensing or design basis or the assumptions or evaluations contained in the ISA. If such authority is exercised, the Engineering Manager must concur with restart of shutdown operations.

The Engineering Manager has as a minimum a bachelor's degree in engineering or the physical sciences or equivalent technical experience, and four years of nuclear experience.

The Lead Cascade Manager appoints the Engineering Manager with concurrence from the Director, Enrichment Technology.

2.1.10 Training Manager

The Training Manager reports to the Lead Cascade Manager.

During the refurbishment/start-up phase of the Lead Cascade, the Training Manager is responsible for preparation, presentation, and documentation of employee orientations, and for technical and qualification training program development and implementation. During this phase, the Training Manager is also responsible for the development and implementation of the procedures program. During the operations phase, the Project Support Manager assumes the responsibilities of the Training Manager and this position is eliminated from the Lead Cascade Organization.

The Training Manager has as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, and four years of nuclear experience.

The Lead Cascade Manager appoints the Training Manager with concurrence from the Director, Enrichment Technology.

2.1.11 Project Support Manager

The Project Support Manager reports to the Lead Cascade Manager.

The Project Support Manager is responsible for the Fire Safety, Emergency Management, and Records Management and Document Control programs for the Lead Cascade. In the absence of the Lead Cascade Manager, the Project Support Manager may be delegated the responsibilities and authorities of the Lead Cascade Manager.

During the refurbishment/start-up phase of the Lead Cascade, the Project Support Manager is also responsible for ensuring adequate transfer of technology (both equipment and intellectual property) from the USEC gas centrifuge Demonstration Project in Oak Ridge, Tennessee. In addition, during the operations phase of the Lead Cascade Project, the Project Support Manager assumes the responsibility for training and procedures.

The Project Support Manager has as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, and four years of nuclear experience.

The Lead Cascade Manager appoints the Project Support Manager with concurrence from the Director, Enrichment Technology.

2.1.12 Quality Services Manager

The Quality Services Manager reports to the Lead Cascade Manager.

During the refurbishment/start-up phase of the Lead Cascade, the Quality Services Manager provides audit, oversight, quality assurance, and quality control services to ensure that the health and safety of the public and workers are adequately protected, to ensure compliance with safety, safeguards, and quality requirements and to ensure implementation of policies, procedures and management expectations. This position is independent of the operations organization. The NS&Q Manager provides programmatic oversight and guidance to the Quality Services Manager in an advisory capacity. This manager has the authority to stop work and/or shut down operations in any part of the Lead Cascade where activities are not being conducted in accordance with applicable quality requirements. If such authority is exercised, the Quality Services Manager must concur with restart of shutdown operations. The Quality Services Manager has the authority and responsibility to contact directly the NS&Q Manager and/or Director, Enrichment Technology with any matters affecting quality that are not resolved with the Lead Cascade Manager. During the operations phase, the NS&Q Manager assumes responsibilities for oversight and quality assurance and this position is eliminated from the Lead Cascade Organization.

The Quality Services Manager has as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience, and four years of nuclear experience.

The Lead Cascade Manager appoints the Quality Services Manager with concurrence from the Director, Enrichment Technology and the NS&Q Manager.

2.1.13 Nuclear Safety and Quality Manager (PORTS)

The NS&Q Manager reports to the Vice President, Operations.

The NS&Q Manager has the responsibility to exercise oversight of facility operations to ensure that the health and safety of the public and workers are adequately protected, to ensure compliance with safety, safeguards, and quality requirements and to ensure implementation of policies, procedures and management expectations. The NS&Q Manager manages the nuclear material control and accountability group.

The NS&Q Manager has authority to shut down operations and/or stop work when necessary to ensure protection of public and worker health and safety and provide for common defense and security and to ensure regulatory and quality compliance. This manager has access to all information at the site related to safety, safeguards and quality. This manager interacts directly with the Lead Cascade Manager, other managers, and key facility personnel and participates, as desired, in any evaluations or discussions related to safety, safeguards and quality. The NS&Q Manager informs the Lead Cascade Manager about safety, safeguards, and quality issues and compliance. The NS&Q Manager's responsibilities for the Lead Cascade are consistent with those exercised at PORTS.

During the refurbishment/start-up phase of the Lead Cascade, the NS&Q Manager provides oversight and guidance to the Quality Services Manager to assure that Quality Assurance policies and procedures are being appropriately implemented for the Lead Cascade.

During the operations phase of the Lead Cascade Project, the NS&Q Manager provides independent oversight and assessment to ensure that the health and safety of the public and workers are adequately protected, to ensure compliance with safety, safeguards, and quality requirements and to ensure implementation of policies, procedures and management expectations.

The NS&Q Manger has as a minimum a technical degree and 15 years nuclear experience with three years of management experience in quality assurance, nuclear safety oversight, engineering and technical support, or regulatory affairs.

2.1.14 Plant Shift Superintendent (PORTS)

The Plant Shift Superintendent (PSS) reports to the PORTS Shift Operations Manager.

As the senior manager on shift, the PSS represents the Lead Cascade Manager and has the authority and responsibility to make decisions as necessary to ensure safe operations, including stopping work and placing the facility in a safe condition. The PSS is responsible for accumulation and dissemination of information regarding facility activities, serving as or designating an incident commander during emergencies, and making notification of events. The PSS provides the Lead Cascade with a centralized point for incident identification, screening, and reporting. The PSS is authorized to stop operations when system operability or the overall safety of operations is in question. The PSS is also authorized to initiate restart after shut down for non-routine reasons. The PSS's responsibilities for the Lead Cascade are consistent with those exercised at PORTS.

The PSS has as a minimum a bachelors degree in engineering or the physical sciences or equivalent technical experience and four years experience at a uranium processing facility, or a high school diploma plus 12 years experience at a uranium processing facility.

2.1.15 Fire Services Manager (PORTS)

The Fire Services Manager reports to the PORTS Plant Services Manager.

The Fire Services Manager is responsible for the day-to-day operation of Fire Services, including interpretation and application of applicable fire codes and standards, and has stop work authority for activities in the Lead Cascade not being conducted in accordance with applicable fire protection requirements. The Fire Services Manager's responsibilities for the Lead Cascade are consistent with those exercised at PORTS.

The Fire Services Manager has as a minimum a bachelors degree or equivalent technical experience, four years of fire protection experience, and six months of nuclear experience.

2.1.16 Nuclear Criticality Safety Manager (PORTS)

The PORTS NCS Manager reports to the Corporation's Director, Engineering.

The position is responsible for the management of NCS functions, including administering the NCS program and conducting assessments of program implementation. These duties include programmatic oversight of NCS and NCS training. The NCS Manager has stop work authority for any activity that could cause a NCS concern. The NCS Manager's responsibilities for the Lead Cascade are consistent with those exercised at PORTS.

The NCS Manager has as a minimum a bachelor's degree in engineering or the physical sciences or equivalent technical experience, and four years nuclear experience, including six months at a uranium processing facility where NCS was practiced.

2.1.17 Shift Crew Composition

The minimum operating shift crew consists of a Lead Cascade Shift Supervisor, one Lead Cascade Operator, and one Radiation Protection/Industrial Hygiene technician.

Table 2.1-1
Responsibilities for Functional Support Provided by
Portsmouth Gaseous Diffusion Plant

Lead Cascade Manager Responsible for Oversight of Functional Support

	Regulatory Manager	**Project Support Manager**	**Engineering Manager**
Functional Support Area provided by the Corporation	Environmental Protection Waste Management Industrial Safety Radiation Protection Industrial Hygiene Security Safeguards Nuclear Material Control and Accountability	Fire Safety Emergency Management Records Management and Document Control	Engineering Nuclear Criticality Safety Procurement

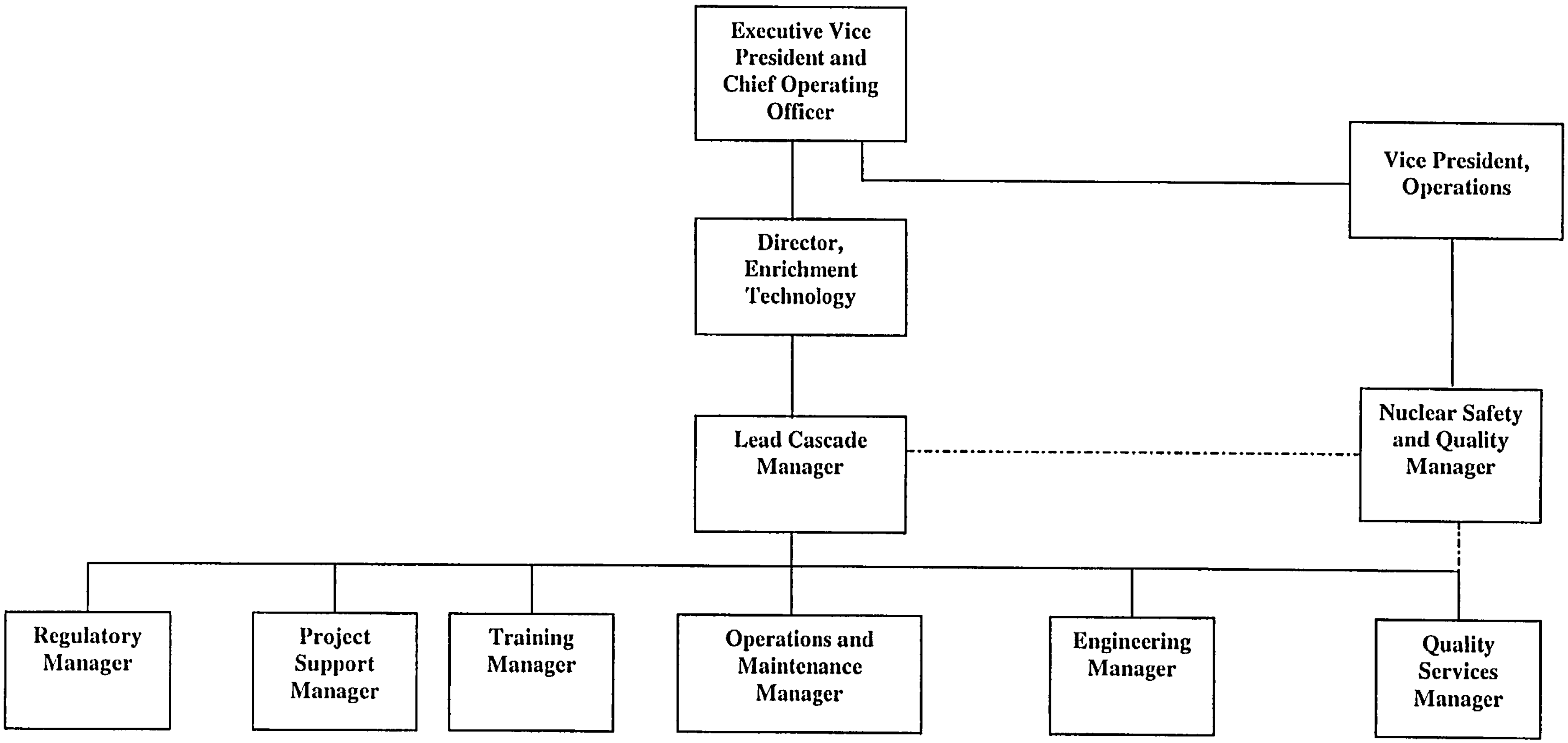

Figure 2.1-1
Lead Cascade Design/Refurbishment/Start-up Organization

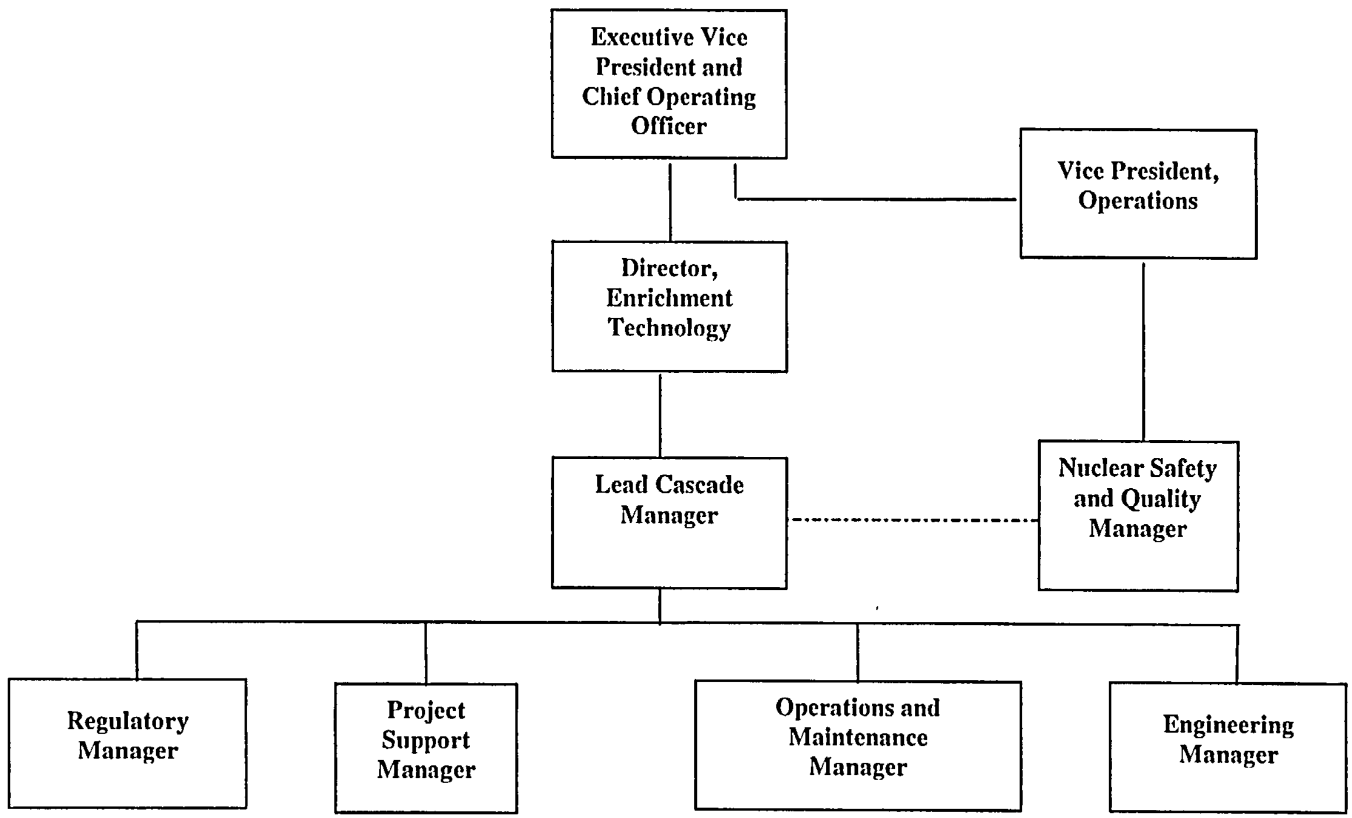

Figure 2.1-2
Lead Cascade Operating Organization

2.2 Management Controls

USEC has established management systems with associated policies, administrative procedures, and management controls to ensure: the Lead Cascade equipment, facilities and procedures; the staff (including training and qualifications); and the programs provide for the protection of the health and safety of workers and the public, protection of the environment, and for the common defense and security. Management controls have been established to maintain configuration management of the Lead Cascade. These controls are described in Section 11.1 of this license application. Organizations with environmental, health, safety, safeguards, security, and quality responsibilities have been established with a reporting chain, independent from the operations organization. Effective lines of communication and authority among the organizations involved in the engineering, environmental, safety, and health, and operations functions of the facility are clearly defined.

The management controls established by USEC for the Lead Cascade include policies, management systems, and administrative procedures that are communicated to Lead Cascade personnel. Policies related to the protection of health and safety of workers and the public, protection of the environment, and providing for the common defense are discussed in pertinent sections of this license application. Activities that are essential for effective implementation of the environmental, safety, and health functions are documented in approved, written procedures, prepared in compliance with a document control program. The procedure development and control process is described in Section 11.4 of this license application and Section 9 of the QAPD.

Management measures required to ensure the availability and reliability of items relied on for safety (IROFS) are described in Chapter 11.0 of this license application. Controls specific to Lead Cascade programs are identified in the QAPD, Fundamental Nuclear Materials Control Plan, and Security Program.

The commitment tracking and corrective action management systems are integrated to prioritize Lead Cascade actions consistent with their safety and safeguards significance. Any person working in the facility may report potentially unsafe conditions or activities by submitting a problem report. Reported concerns are investigated, assessed, and resolved as described in Section 11.6 of this license application.

Where safety or safeguards might be adversely impacted by cost or schedule considerations, it is the policy of USEC to subordinate cost and schedule considerations to ensure adequate treatment of safety and safeguards in full compliance with applicable regulatory requirements.

The integration of Lead Cascade operations and the various programs and requirements is accomplished through a variety of management practices, including:

- Staff meetings to discuss issues and policy implementation
- Review of performance indicators
- Review of identified events or conditions
- Multi-discipline reviews by the Facility Safety Review Committee (FSRC)
- Plant work permit systems that provide the integration in the field of various health, safety, and environmental program requirements and hazard evaluations

Additionally, oversight of the integration of various program elements is provided by the PORTS NS&Q Organization.

Written interface agreements exist with offsite emergency resources such as fire, police, ambulance/rescue units, and medical services. These interface agreements are addressed in more detail in the PORTS Emergency Plan.

2.2.1 Facility Safety Review Committee

The FSRC performs multi-discipline reviews of day-to-day and proposed Lead Cascade activities to ensure that these activities are and/or will be conducted in a safe manner. The FSRC advises the Lead Cascade Manager on matters related to Radiation Protection, Nuclear Safety, Chemical Safety, Fire Safety, and Environmental Protection. The specific membership, qualifications, meeting frequency, quorum, functions, responsibilities, and required records are provided in a facility procedure. Auditing and oversight of FSRC activities is the responsibility of the NS&Q Manager.

Subcommittees may be established by the FSRC chairperson to provide assistance in conducting reviews and assessments as described in the FSRC procedure. The FSRC chairperson approves the subcommittee procedures, membership, and member qualifications. The FSRC maintains the overall responsibility for any required reviews.

2.3 Pre-operational Testing and Initial Start-up

Specific plans have been established to ensure the safe and efficient turnover, testing, and start-up of Lead Cascade centrifuge machines, equipment, and support systems. These plans cover the transition from the refurbishment phase to the operations phase of the Lead Cascade Project.

The Engineering Manager is responsible for development and implementation of testing to provide for the turnover and acceptance of equipment and systems from contractors/vendors to USEC.

The Operations and Maintenance Manager is responsible for the development and execution of the Integrated Systems and Test Plans (ISTPs). The Engineering Manager may assist in the development of ISTPs. The ISTPs demonstrate the proper operation of completed systems to ensure the systems meet their intended design functions. This manager is also responsible for the testing, initial start-up, and operation of the centrifuge machines, equipment, and support systems. Documentation of testing is maintained in accordance with records management and document control requirements, and is available for NRC review.

2.3.1 Pre-operational Testing Objectives

The overall objectives of the pre-operational test program are to ensure that the Lead Cascade facilities and systems, including the IROFS:

- Have been adequately designed and constructed
- Meet contractual, regulatory, and licensing requirements
- Do not adversely affect worker or public health and safety
- Can be operated in a dependable manner so as to perform their intended function

2.3.2 Turnover, Functional, and Initial Start-up Test Program

The refurbishment contractor is responsible for completion of as-built drawing verification, purging/flushing, cleaning, hydrostatic or pneumatic testing, system turnover, and initial calibration of instrumentation in accordance with design and installation specifications. As systems or portions of systems are turned over to USEC, acceptance testing is performed in accordance with established schedules. The Engineering Manager is responsible for coordination of turnover and acceptance testing for the Lead Cascade.

Integrated systems testing, as a minimum, includes system or component tests required by the pertinent design codes or Quality Assurance Program Description that were not performed by the refurbishment contractor prior to turnover to USEC. The testing that is performed is commensurate with the system or component's quality level and is principally associated with IROFS, but may also include other tests on systems or components that USEC deems appropriate for financial, reliability, or other reasons. Integrated systems tests include the testing that is necessary to demonstrate that the facility, system, or component is capable of performing its intended function. The Operations and Maintenance Manager is responsible for coordinating the ISTP for the Lead Cascade. The integrated systems tests are performed following completion of construction, flushing and hydrostatic or pneumatic testing, system turnover, and initial calibration of required instrumentation. Scheduling of the testing is such that it generally occurs prior to UF_6 introduction. Other pre-operational tests, not required prior to UF_6 introduction, may be performed following introduction of UF_6 to the process system.

The purpose of initial start-up testing is to ensure safe and orderly UF_6 separation and control. Examples of initial start-up tests include the leak testing, evacuation, start-up, and filling of a centrifuge machine.

2.4 References

1. Gas Centrifuge Quality Assurance Program Description, AET 03-0006, Steven A. Toelle letter to Mr. Martin J. Virgilio, dated February 3, 2003

2. NUREG-1324, *Proposed Method for Regulating Major Materials Licensees*

3. NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*

4. USEC-02, Application for United States Nuclear Regulatory Commission Certification, Portsmouth Gaseous Diffusion Plant, Safety Analysis Report

5. USEC-02, Application for United States Nuclear Regulatory Commission Certification, Portsmouth Gaseous Diffusion Plant, Emergency Plan

4.0 RADIATION PROTECTION

This chapter describes the Lead Cascade Radiation Protection (RP) Program for keeping occupational radiation exposures and radioactive contamination as low as reasonably achievable (ALARA). The RP program addresses the occupational radiation protection requirements set forth in 10 *Code of Federal Regulations* (CFR) Parts 19, 20, and 70. The RP Program is based on the well-established Portsmouth Gaseous Diffusion Plant (PORTS) program and is implemented through written procedures. The Regulatory Manager is responsible for the Lead Cascade RP Program. Responsibilities of the Radiation Protection Manager (RPM) described in this chapter are carried out by the RPM from PORTS or designee. USEC's program for minimizing and monitoring doses to the public and the environmental are discussed in Chapter 9.0 of this license application.

4.1 Radiation Protection Program Implementation

In accordance with 10 CFR 20.1101(c), the RP Program content and implementation is reviewed annually. The RPM is responsible for this annual review and preparation of a report documenting the results of the review. The ALARA Committee then reviews the report. Revisions to the RP Program, if warranted, are initiated by the RPM and submitted to the Lead Cascade Regulatory Manager for further processing, as part of the annual review process.

4.2 ALARA Program

In accordance with 10 CFR 20.1101, USEC Inc. (USEC) has established an RP Program for the Lead Cascade designed to protect personnel entering the Lead Cascade facilities from unnecessary exposure to ionizing radiation and radioactive materials. This program is based upon the following principles and is implemented through written procedures.

- Personnel radiation exposures and the release of radioactive effluents shall be maintained in accordance with the ALARA principle.

- No individual shall receive a radiation dose in excess of any regulatory limit.

Responsibility for establishing and ensuring adherence to this policy rests with the USEC Executive Vice President and Chief Operating Officer. The Lead Cascade Manager has the overall responsibility and authority for the ALARA Program. The Regulatory Manager is responsible for establishing and implementing the ALARA Program, with guidance and programmatic direction from the RPM.

4.2.1 ALARA Committee

The ALARA Committee is an independent advisory group to the Lead Cascade Manager on RP issues. It functions to: (1) monitor selected operational RP issues; (2) advise Lead Cascade management on RP concerns; and (3) review proposed designs, work practices, selected suggestions, and selected projects with regard to contamination control and/or ALARA.

The ALARA Committee:

- Communicates management's commitment to the ALARA Program;
- Monitors the implementation of the ALARA Program and serves as advisor to Lead Cascade management for maintaining occupational dose and environmental dose in accordance with ALARA principles; and
- Reviews, for the purpose of occupational dose and environmental dose reduction, proposed designs, practices, selected suggestions, and selected project schedules.

The ALARA Committee also:

- Establishes the annual exposure goals;
- Provides recommendations to line management and/or the Facility Safety Review Committee when determined appropriate, regarding procedural, equipment, or design changes that could have a significant impact on personnel radiation exposure; and
- Forms subcommittees or assigns individuals to undertake special studies or conduct ALARA reviews that will be documented and presented to the ALARA Committee with any recommendations.

Membership consists of persons from various functional disciplines of the Lead Cascade who have the necessary competence and experience to perform the functions of the committee. Standing committee members are the RPM who serves as the chairperson, the vice-chairperson who is appointed by the RPM, the Engineering Manager, the Operations and Maintenance Manager, the Regulatory Manager, and a Lead Cascade operator or mechanic. Participation from other functional disciplines may vary depending on the issue of concern. The committee chairperson, or designee, is responsible for requesting appropriate functional representation. Committee members may designate an alternate to attend committee meetings in their place.

The ALARA Committee meets at least annually and as directed by the chairperson. A quorum consists of five standing committee members or their alternates. Ad hoc subcommittees may be established for special studies or reviews pertinent to committee-related issues.

The chairperson ensures those functions of the committee and tasks are properly executed. Minutes are provided to the Director, Enrichment Technology and the Lead Cascade

Manager. The committee issues special reports prepared upon request of Lead Cascade management, or as determined by the chairperson.

The committee reviews matters that have or may have an impact on contamination control and/or ALARA. The ALARA Committee reviews the ALARA program and the review includes an evaluation of the results of audits made by the RP organization, reports of radiation levels in the facility, contamination levels, employee exposures, and effluent releases, etc. The review determines if there are any upward trends in personnel exposure for identified categories of workers and types of operations. The review also identifies any upward trends in effluent releases and contamination levels and determines if exposures, releases, and contamination levels are in accordance with the ALARA concept. Specific areas reviewed includes, but are not limited to the following:

- Technologies for selected job tasks;
- Current work practices and completed tasks which have/had contamination control or ALARA concerns;
- Radiation protection violations;
- Lessons learned;
- Trends and resulting impacts on contamination control and/or ALARA; and
- Environmental monitoring reports.

The committee also establishes annual contamination control and exposure goals. Minutes are issued that identify committee members and/or alternates in attendance, agenda items, a summary of decisions made, and action items. Copies are made available to Lead Cascade management and the committee members. The Regulatory Manager ensures recommendations of the ALARA Committee are documented and tracked to completion.

4.3 Organization and Personnel Qualifications

The RPM is responsible for providing guidance and direction for establishment and implementation of the RP Program to the Regulatory Manager. The RPM and designee are required to have the technical competence and experience to establish RP programs and the management capability to direct the implementation and maintenance of RP programs.

The PORTS Health Physics (HP) Group reports to the RPM and provides radiological protection support to the facility, is independent of the organizations responsible for production, and has an equivalent reporting level. The HP Group is staffed with suitably trained individuals who provide oversight and control of the technical aspects of the program elements that affect RP. There are sufficient HP resources available to support Lead Cascade activities.

HP Technicians and their managers perform the functions of assisting and guiding workers in the radiological aspects of the job. HP Technicians and their managers have the responsibility and authority to stop radiological work or mitigate the effect of an activity if they suspect that the initiation or continued performance of a job, evolution, or test will result in the violation of approved RP requirements.

4.4 Written Procedures

4.4.1 Procedures

The RP Program is implemented using procedures. The procedures are prepared consistent with the requirements of 10 CFR Part 20 and are approved, maintained, and adhered to for operations involving personnel radiation exposure and toxicological exposure to soluble uranium. The procedures are reviewed and revised as necessary to incorporate any facility or operational changes, including these initiated by changes to the Integrated Safety Analysis. These procedures are prepared, maintained and made available to appropriate personnel at the facility as described in Section 11.4 of this license application.

4.4.2 Radiation Work Permits

Radiation Work Permits (RWPs) are a basic implementing tool by which radiological controls are established. RWPs provide information to the worker concerning protective clothing, job/task identification, and special instructions such as radiological hold points. Radiological surveys that supplement RWPs provide information regarding radiation and contamination levels.

RWPs are required for work activities in Contamination Areas (CAs), High Contamination Areas (HCAs), Airborne Radioactivity Areas (ARAs), Radiation Areas (RAs), High Radiation Areas (HRAs) and other areas as required by HP. Qualified HP personnel are authorized to approve, issue, update, revise, and close RWPs. The RPM may exempt the requirement for an RWP in certain RAs as specified in approved procedures.

The limits established for contamination control (surface and airborne) are based on the toxicity of soluble uranium. The contamination control program, of which RWPs are a part, is designed to ensure that the inhalation or ingestion of soluble uranium is below the limits stated in 10 CFR 20.1201(e).

An RWP may be issued for any period up to one year, based on the stability and predictability of changes in the radiological conditions of the work area. RWPs are normally closed upon job completion. HP may close an RWP at any time.

Radiological surveys are reviewed to evaluate the adequacy of RWP requirements. RWPs are updated or closed and reissued if radiological conditions change to the extent those protective requirements need to be modified.

HP management reviews the RWP closure package to ensure appropriate actions have been taken.

Continuous HP coverage may be used in lieu of RWPs when approved by the RPM. Qualified HP Technicians are authorized to provide continuous radiological coverage in lieu of an RWP for short duration (less than one shift), non-complex tasks. When continuous HP coverage is used, requirements normally specified on an RWP are communicated to the worker verbally.

4.5 Training

Radiological control is provided by controlling access to Lead Cascade areas where radioactive material may be encountered and by requiring that each person who enters those areas or facilities receive the appropriate level of radiological worker training. Personnel are trained commensurate with the hazard per 10 CFR Parts 19 and 20. Details concerning Visitor Site Access Orientation and radiological training are described in Section 11.3.5 of this license application. The Radiation Worker Training program is described in Section 11.3.6 of this license application.

4.5.1 Visitor Site Access Orientation

Visitors review basic information related to the site and hazards present at the Lead Cascade. Visitors granted access to the Lead Cascade restricted areas are escorted by trained radiological workers.

4.5.2 General Employee Radiological Training

General Employee Radiological Training covers the employee's responsibilities for maintaining exposures to radiation and radioactive materials in accordance with the ALARA philosophy.

4.5.3 Radiation Worker Training

If a person requires unescorted access to the Lead Cascade restricted area, radiological worker qualification is required. Radiation Worker Training is a biennial training requirement.

4.5.4 Health Physics Technician

HP Technicians and their managers are qualified and trained in accordance with an approved qualification standard and is delivered consistent with the training procedures (see Section 11.3). Training develops the skills necessary to perform assigned work in a competent manner. The training consists of initial, on-the-job, and continuing training.

HP Technician qualification consists of the standardized core course training material, facility-specific information, and on-the-job training. Passing a final comprehensive written examination is required. The training program ensures personnel are proficient in radiation measurements, characterization of radiological conditions, release monitoring, and personnel monitoring. Formal remediation protocols are utilized.

Entry-level prerequisites are established to ensure that HP Technicians meet minimum standards for education. Task qualification for entry-level positions may be used until formal training is completed.

Following initial qualification, HP Technicians are requalified every two years. The requalification process requires successful completion of a comprehensive written examination. The written examination may be waived for personnel with National Registry of Radiation Protection Technologist certification. Personnel, who maintain qualifications as HP Technicians, satisfy the requirements of Radiation Worker Training.

HP Technician managers maintain qualifications as HP Technicians and participate in continuing radiological training programs.

4.6 Ventilation and Respiratory Protection Programs

Lead Cascade ventilation systems are described in Section 1.1.2.7.5 of this license application.

4.6.1 Ventilation

In addition to general ventilation systems, portable ventilation units may be employed for short duration jobs when the unprotected worker could potentially exceed 0.8 Derived Air Concentration (DAC)-hours of exposure. These local ventilation units are equipped with high efficiency particulate air (HEPA) filters and designed to re-circulate and discharge room air at low velocities. Activities where these units may be employed are also subject to approval by Nuclear Criticality Safety.

When used for radiological protection purposes, the portable HEPA filtered ventilation units differential pressure is checked per operating procedure. The operating differential pressure range is based on manufacturer's recommendations or as specified in the technical design basis. HEPA filter systems, both fixed and portable, are efficiency tested in accordance with American Society of Mechanical Engineers (ASME) N510-1989, *Testing of Nuclear Air-Treatment Systems,* as it applies to radiological contaminants likely to be found at the Lead Cascade. Portable HEPA filter units use is normally specified on the RWP.

HEPA filter systems are utilized by USEC to perform specific functions. HEPA filter systems required to implement ALARA principles and to control workers exposure are tested in accordance with ASME N510-1989. For those systems not designed in accordance with ASME N509-1989, *Nuclear Power Plant Air-Cleaning Units and Components,* ASME N510-1989 is used as testing guidance.

The average air velocity through openings in uranium sampling and handling hoods containing readily dispersible uranium is a minimum of 100 linear feet per minute (lfpm). This velocity is checked at least annually.

If "glove boxes" are used for Lead Cascade activities, when they are in use and have the potential to generate airborne radioactivity, they will be maintained at a negative differential pressure.

4.6.2 Respiratory Protection

The Respiratory Protection Program follows the requirements of 29 CFR 1910.134 and 10 CFR Part 20 for use, issuance, training, and qualifications for respirator users. There is a written Lead Cascade policy statement on respirator usage following the requirements of 10 CFR 20.1703(c)(4). RWPs specify respiratory protection required for radiological protection purposes. Respirator use is considered for activities where an individual may be exposed to soluble uranium that may exceed 0.8 DAC-hours or an intake of 1 milligram (mg) of soluble uranium during a work shift.

Engineering and administrative controls, including access restrictions and the use of specific work practices designed to minimize airborne contamination or loss of contamination control are used to minimize worker internal exposure. When engineering and administrative controls have been applied and the potential for airborne radioactivity still exists, respiratory protection is used to limit internal exposures. Use of respiratory protection is considered under any of the following conditions:

- During entry into posted ARAs;
- During breach of contaminated systems or components;
- During work in areas or on equipment with removable contamination levels greater than 100 times the levels in Table 4.6-1; and
- During work on contaminated surfaces with the potential to generate airborne radioactivity.

In specific situations, respiratory protection may not be used due to physical limitations, such as heat stress, or the potential for significantly increased external exposure with approval of the RPM. In such situations, stay time controls to limit intakes are established and continuous workplace airborne monitoring is provided along with expedited analysis of results.

Table 4.6-1
Contamination Levels

Nuclide[a]	Removable (dpm/100 cm^2)[b]	Total (Fixed + Removable) (dpm/100 cm^2)
U-natural, ^{235}U , ^{238}U, and associated decay products, Transuranics $\leq$ 2 percent by alpha activity, ^{99}Tc , and beta-gamma emitters	1,000	5,000
Transuranic modified materials containing > 2 percent and < 8 percent transuranics by alpha activity, Th-natural, ^{232}Th, ^{223}Ra, ^{224}Ra, and ^{232}U	200	1,000
^{226}Ra, ^{228} Ra, ^{230}Th, ^{228}Th, ^{231}Pa, ^{227}Ac, ^{125}I, ^{129}I, and Transuranics $\geq$ 8 percent by alpha activity	20	500

a. The values in this table apply to radioactive contamination deposited on, but not incorporated into the interior of, the contaminated item. Where contamination by both alpha and beta-gamma-emitting nuclides exists, the levels established for the alpha- and beta-gamma-emitting nuclides apply independently.

b. The amount of removable radioactive material per 100 square centimeters (cm^2) of surface area is determined by swiping the area with a dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface is swiped; and the activity per unit area is based on the actual surface area. Except for transuranics $\geq$ 8 percent by alpha activity, ^{228}Ra, ^{227}Ac, ^{228}Th, ^{230}Th, ^{231}Pa, and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination is within the levels for removable contamination.

The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm^2 is less than three times the level specified. For purposes of averaging, any square meter of surface is considered to be above the level G if: (1) from measurements of a representative number of n of sections it is determined that $1/n \Sigma_n S_i \geq G$, where S_i is the disintegration per minute (dpm)/100 cm^2 determined from measurements of section i; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds 3G. (G is defined as the levels listed above.)

4.7 Radiation Surveys and Monitoring Program

The Radiation Surveys and Monitoring Programs are based on the requirements of 10 CFR Part 20 and ALARA principles. Deficiencies associated with surveys and monitoring program or results that exceed the administrative control levels are dispositioned in accordance with the Quality Assurance Program Description and the Corrective Action Program, described in Section 11.6 of this license application.

4.7.1 Surveys

The radiological survey program consists of routine, work support, and material release surveys. Surveys are conducted to support facility activities in a manner that ensures radiological hazards associated with each activity are properly identified, and relative radiation levels and concentrations of radioactive material are determined. Radiological surveys for the purposes of establishing personnel protection equipment or for posting requirements is performed by qualified HP personnel. Decontamination is performed as appropriate considering the gained benefit from waste minimization, ALARA principles and worker access.

The routine survey program involves surveys of the facility to determine workplace radiological conditions, effectiveness of contamination control measures, and proper identification and posting of radiological hazards. Routine survey frequencies are established based on the stability of operations as demonstrated by the consistency of survey results. Areas within the facility are categorized and scheduled for survey commensurate with their relative radiological hazard and contamination potential. Survey frequencies are based on area occupancy, potential for spread of contamination, and process knowledge. The routine survey program is reviewed annually by the RPM, documented, maintained, and modified to reflect changes in radiological conditions. Table 4.7-1 provides the contamination survey program frequencies for Lead Cascade areas.

In the event that large areas of removable contamination are identified on accessible surfaces exceeding the levels specified in Table 4.6-1, the area will be re-posted as a CA or HCA and actions taken to locate the source of contamination. If access is required to the area, decontamination of the area is initiated as soon as practical with consideration of ALARA principles.

Work support surveys are a fundamental element of the RWP process. In-process surveys are conducted as necessary to verify radiological conditions at various points in the work activity and to ensure exposure potentials are maintained in accordance with the ALARA principle. When required by work activities, surveys are conducted by qualified personnel to support decontamination efforts and the release of tools, equipment, and waste material from the work area.

4.7.2 Personnel Monitoring

Both U.S. Nuclear Regulatory Commission (NRC) and U.S. Department of Energy (DOE) regulated sources of radiation and radioactive materials are interspersed on the PORTS reservation. There is also a frequent moving of personnel from a USEC contractor or sub-contractor staff to a DOE contractor or sub-contractor staff. This situation makes separation of personnel exposure between NRC and DOE regulated sources impractical.

To comply with the personnel monitoring requirements of 10 CFR 20.1502 and the reporting requirements of 10 CFR 19.13, 20.2106 and 20.2206, USEC tracks exposures for personnel issued National Voluntary Laboratory Accreditation Program (NVLAP)-accredited dosimeters regardless of whether the exposure is from an NRC or DOE regulated source. Whenever worker notification is required by 10 CFR 19.13, the individual's "total exposure" while on the PORTS site is reported without differentiating between exposure from NRC-regulated sources and DOE regulated sources.

The established personnel monitoring program consists of the following:

- An Administrative Control Level (ACL) of 500 millirem (mrem) per year Total Effective Dose Equivalent per person;
- The intake limit for soluble uranium is set at 10 mg per week;
- Personnel dosimeters to measure the external exposure of personnel;
- Analysis of personnel occupational exposure and maintenance of exposure records; and
- A network of Fixed Nuclear Accident Dosimeters (FNADs) is situated in the Lead Cascade area. Dosimeters in the FNADs are processed by a NVLAP accredited dosimeter reader. The FNADs serve as area monitors.

Personal dosimeters are also evaluated for neutron dose. In addition, security badges contain an indium foil that can be evaluated for neutron activation. If the indium foil indicates exposure to a neutron flux exceeding 10 rads, the dosimeter is read and/or biological materials of personnel may be evaluated.

4.7.3 External

Persons requiring radiation exposure monitoring per 10 CFR 20.1502(a) wear beta-gamma-sensitive dosimeters which are processed and evaluated by a processor holding current NVLAP accreditation from the National Institute of Standards and Technology (NIST). Dosimeters are exchanged at least quarterly (+/-2 weeks) unless authorized in writing by the RPM. The dosimeters may be supplemented, as appropriate, by other types of dosimeters (e.g., finger rings, direct-reading dosimeters, and neutron dosimeters) and by radiation measurements made with radiation survey instruments. Self-reading or alarming dosimeters are used for entry into HRAs or Very High Radiation Areas.

If an individual exceeds 50 percent of the ACL during a calendar quarter or the ACL in the calendar year, an evaluation is performed by the RPM for approval by the Lead Cascade

Manager. The evaluation is performed to determine the types of activities that may have contributed to the worker's exposure. This may include, but is not limited to, procedural reviews, work practices, work locations, and job assignments. Depending upon the conclusions of the evaluation, the individual may be allowed to continue radiological work; however, work restrictions may be imposed on individuals whose exposure exceeds the ACL.

Approval for continued work is documented in the evaluation, as described in the preceding paragraph, which requires approval by the Lead Cascade Manager. Investigations to determine cause, assess the exposure, and document the results are specified by procedure.

External dosimetry results are reviewed by HP to determine any unusual trends or exposures. If the external exposure status of an individual is uncertain, the individual is removed from further exposure until HP determines the exposure status and advises management of any special controls or restrictions to be applied.

To comply with the reporting requirements of 10 CFR 20.2206, the site submits personnel monitoring information for the Radiation Exposure Information Reporting System (REIRS) report based on the personnel exposure database. Dose reports are completed as required for personnel monitored in accordance with 10 CFR 20.1502(a).

The occupational exposure received by USEC employees, subcontractors, and visitors must not exceed the 10 CFR Part 20, Subpart C limits. USEC requires current year exposure history of an occupational worker as required by 10 CFR 20.2104.

Personnel declaring pregnancy are advised to keep radiation exposure to an embryo or fetus in accordance with the ALARA principle during the entire gestation period. USEC complies with the guidelines of Regulatory Guide 8.13, Revision 2, *Instructions Concerning Prenatal Radiation Exposure.*

4.7.4 Internal

The chemical characteristics and retention times of soluble uranium processed at the Lead Cascade are such that renal toxicity limitations are the limiting conditions for health effects. Historical experience at the gaseous diffusion plants (GDPs) indicates that exposure derived from low level chronic exposure is less than two percent of the annual radiation exposure limits specified in 10 CFR 20.1201.

A bioassay program is employed to confirm the results of radioactive material contamination control and respiratory protection programs. Bioassay results are the primary means of calculating internal doses. Personnel who have the potential to receive intakes resulting in a Committed Effective Dose Equivalent (CEDE) greater than or equal to 0.1 roentgen equivalent man (rem) CEDE in a year or intakes of 1 mg of soluble uranium per week participate in the routine bioassay program.

Personnel submit bioassay samples, such as urine or fecal samples, and participate in *Invivo* monitoring as required by the bioassay program. Table 4.7-2 gives a program description and the analytical methods employed. The routine sample submission frequencies and administrative control levels are listed in Table 4.7-3.

Because chemical toxicity is limiting when exposed to soluble uranium, the uranium action levels have been selected to limit an individual's chronic intake to 10 mg of soluble uranium per week. Personnel participate in follow-up bioassay monitoring when their bioassay results exceed administrative control levels or as determined by HP. Special bioassay studies are performed as necessary and investigations performed when intakes are confirmed or suspected to exceed 1 mg of soluble uranium per week.

USEC collects "random single void" urine samples from personnel. Isotopic analysis of fecal samples and 24-hour urine sampling are not routinely performed, however, these analyses will be considered when dose assessments exceed 0.5 rem CEDE. Bioassay results are used to assign internal dose. The sensitivities of lung counting systems are not as effective as urinalysis for Class D uranium; lung counting is considered when intake estimates exceed 0.5 rem CEDE.

The CEDE per unit of intake by inhalation from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion,* is used to calculate internal dose.

Urinalysis results are reviewed by HP to determine unusual trends. If bioassay sample results indicate an internal exposure that exceeds action levels or appears uncertain, additional analyses and removal of the individual from further exposure are considered.

4.7.5 Airborne Radioactivity

Routine general area air sampling is established in Lead Cascade areas where airborne radioactivity concentrations may exceed 10 percent of the DAC listed in Table 4.7-4, averaged over 8 hours. Table 4.7-4 also summarizes the airborne radioactivity posting levels. Investigations are performed when airborne radioactivity data indicates personnel exposures exceed 0.8 DAC-hours. Special bioassay sampling is required when air samples exceed 0.8 DAC-hours, adjustment for respirator use is considered in determining bioassay monitoring.

A combination of low-volume, high-volume, and lapel air samplers are used for job coverage and general area air sampling. Low-volume air samplers are used for routine air sampling and are exchanged at least weekly. Due to radon and radon daughter products, air samples are routinely allowed to decay for a minimum of three days.

Air sample data is not used as the primary method to determine internal dose, however the data is used to prompt bioassay monitoring. Only air samples collected in the workers breathing zone (approximately 30 cm) are considered representative.

Air sample flow measurement devices are calibrated under standard laboratory conditions at least annually. The NIST traceable standards used have accuracy and precision of 20 percent or better. Lapel samplers are calibrated as described by use procedure.

Table 4.7-1
Routine Contamination Survey Frequencies

Area Surveyed	Survey Frequency
Lead Cascade Uranium Processing Area	Yearly[a]
Contaminated Maintenance Areas	Quarterly
Contamination Control Zones (CCZ)	Quarterly
Lead Cascade Lunchrooms/Breakrooms	Note c
Permanent Boundary Control Stations (BCS)[b]	Weekly
Lead Cascade Change Rooms	Monthly
Lead Cascade UF_6 Sample Handling Laboratories	Monthly[a]

a. Localized area surveys are taken following an indication of release and during maintenance activities.

b. When personnel contamination is detected at the BCS, the ensuing follow-up activities include a physical survey of the BCS.

c. Surveys are performed daily during normal facility working days (i.e., Monday through Friday). Weekends and facility holidays are excluded.

Table 4.7-2
Bioassay Program

Urine Bioassay Capabilities	Comment
Workers Participation	Selected based on work locations
Frequency of Urine Monitoring	Monthly[a]
Routine Urine Sample Volume	Single void sample, between 60 and 100 mL
Primary Uranium Analysis Methods	Fluorimetry or Inductively Coupled Plasma (ICP) Mass Spectroscopy
ICP Mass Spectroscopy Minimum Detectable Concentration	<0.006 µg/L ^{235}U <0.015 µg/L ^{238}U
Fluorimetry Minimum Detectable Concentration	5 µg/L Total Uranium

Additional Analytical Capabilities	
Alpha Spectroscopy	0.1 pCi/sample[b]
Uranium Alpha with Proportional Counter	40 dpm/L Total Uranium in urine
Invivo Lung Counting	0.2 nCi ^{235}U 4 nCi ^{238}U
Dose Assessment Software	INDOS (Routine Analysis) CINDY (Developmental and Special)

a. Samples scheduled for submission every four weeks.

b. Equipment also used for loose contamination and airborne radioactivity samples for characterization efforts.

Table 4.7-3
Internal Dosimetry Program Action Levels

Bioassay Technique	Frequency	Action Level	Actions to be Taken
Urinalysis Routine	Monthly[a]	5 µg U/L	Resample to confirm result and determine intake[b]
	Monthly	20 µg U/L	Restrict individual and resample to determine intake[b]
Urinalysis Special	2-6 hours after intake	5 µg U/L	Resample to confirm result and determine intake[b]
		300 µg U/L	Restrict individual and resample to determine intake[b]
	16-30 hours after intake	5 µg U/L	Resample to confirm result and determine intake[b]
		50 µg U/L	Restrict individual and resample to determine intake[b]
Lung Counting	As Required	>100 µg ^{235}U or 7 nCi Total U	Recount to confirm result and perform urinalysis

a. In addition, personnel may be assigned a special frequency if deemed necessary by HP.

b. When intake is confirmed to be > 1 mg uranium, an investigation is performed to identify the source of the exposure, assess the impact, and if practical, a means to prevent reoccurrence.

Table 4.7-4
DAC and Airborne Radioactivity Posting Levels

NUCLIDE[a]	DAC[c, d]	POSTING LEVEL[b]
Gross Alpha based on Class D ^{234}U and 2 percent Class W ^{230}Th	1.0×10^{-10}	1.0×10^{-11}
Gross Alpha based on Class D ^{234}U and 8 percent Class W ^{230}Th	3.0×10^{-11}	3.0×10^{-12}
Gross Alpha based on Class W ^{230}Th	3.0×10^{-12}	3.0×10^{-13}
Gross Beta-Gamma based on Class Y ^{234}Th	6.0×10^{-8}	6.0×10^{-9}

a. All values are listed with units of µCi/mL.

b. Posting Levels are 10 percent of DAC.

c. The values above are assumed as worst case, i.e., ^{230}Th is present in each mixture at the highest concentration per category as described.

d. Area may be posted based on calculated DACs from actual airborne radioactivity concentration data.

4.8 Additional Program Elements

4.8.1 Posting and Labeling

Caution signs for Radioactive Material Areas (RMAs), ARAs, RAs, and HRAs are maintained as required by 10 CFR 20.1901, 20.1902, 20.1903, 20.1904, and 20.1905. RMAs located within a posted CCZ, CA, HCA, ARA, RA, HRA or other posted radiological area are not required to be posted as an RMA since a higher level of control is already required. In addition, as noted in Section 1.2.5 of this license application, the following exception to the applicable 10 CFR Part 20 requirements has been taken and requires an exemption:

- UF_6 feed, product, and depleted uranium cylinders, which are routinely transported inside the reservation boundary between facility locations and/or storage areas at the facility, are readily identifiable due to their size and unique construction, and are not routinely labeled as radioactive material. Qualified radiological workers constantly attend UF_6 cylinders during movement.

4.8.2 Contamination Control

4.8.2.1 Access to Restricted Areas

Restricted Areas are areas to which access is limited by USEC to protect individuals against undue risks from exposure to radiation and radioactive materials. Unescorted access to Restricted Areas requires the successful completion of the appropriate level of radiological worker training and, if required, a personnel dosimeter. Depending upon the type and extent (or amount) of radioactive material present, Restricted Areas are further identified as RMAs, CCZs, CAs, HCAs, ARAs, RAs, or HRAs.

Radiological control is provided by controlling access to Lead Cascade areas where radioactive material may be encountered and by requiring that each person who enters those areas or facilities receive the appropriate level of radiological worker training. Access and departure requirements are specified by procedure and/or reiterated in RWPs. Radiological posting is used to alert personnel to the presence of radiation and radioactive materials, aid in minimizing exposures, and prevent the spread of contamination. Where contamination is present, contamination controls are implemented.

Table 4.8-1 provides definitions and criteria used for posting Lead Cascade Restricted Areas.

4.8.2.2 Equipment and Personnel Monitoring

Personnel exiting areas controlled for removable contamination (CCZs and CAs) are required to monitor themselves for contamination after removing their protective clothing and prior to leaving the step-off pad area. Equipment and materials are monitored and decontaminated if required prior to removal from, or are contained and controlled as radioactive material.

4.8.2.3 Personal Protective Equipment

Protective clothing is provided for personnel entering contaminated areas. The type(s) of clothing required is consistent with the individual's work assignment and is dependent upon the type and level of contamination anticipated. With the exception of emergency evacuations, protective clothing is removed prior to exiting the BCS as specified in Radiation Worker Training, RWP, area posting, or procedures. During emergency evacuations, personnel report to designated assembly points and/or monitoring stations where protective clothing is removed and contamination monitoring is performed.

Industrial safety equipment, such as face shields, goggles, and acid suits are available. In addition full-face negative pressure respirators and full-face positive pressure respirators and other National Institute for Occupational Safety and Health and Mine Safety and Health Administration approved devices may also be utilized for respiratory protection in accordance with Section 4.6.2.

4.8.2.4 Release of Materials and Equipment

Materials and equipment are not released for unrestricted use unless the contamination levels are less than the levels specified in Table 4.6-1. Contamination surveys are performed on materials, equipment, and facilities to be released from radiological controls.

Use histories are used to supplement surveys of materials or equipment that have inaccessible surfaces. Use histories are summaries of the operational history of the item. Use history information includes the function, location(s) where the item was used, and other relevant evidence to assess the item's potential for internal contamination.

Bulk, aggregate materials, or waste to be released for unrestricted use or disposal is specified in the Radioactive Waste Management Program Document.

4.8.3 Radioactive Source Control

The Radioactive Source Control Program maintains administrative and physical control of sealed radioactive sources. The Source Control Program establishes source custodians and requires leak testing, accountability, and control of sealed radioactive sources.

Each sealed source containing more than 100 microcurie (μCi) of beta and/or gamma emitting material or more than 10 μCi of alpha emitting material, other than ^{3}H, with a half-life greater than 30 days and in any form other than gas, is tested for leakage and/or contamination at intervals not to exceed six months. In the absence of a certificate from a transferor indicating that a test has been made within six months prior to the transfer, the sealed source is not put into use until tested.

Sealed plutonium alpha sources containing 0.1 μCi or more of plutonium, when not in use, are stored in a closed container adequately designed and constructed to contain plutonium that might otherwise be released during storage. When in use, USEC will test the sources at least every three months using radiation detection instruments capable of detecting 0.005 μCi of alpha contamination.

Leak tests are taken from the source or from appropriate accessible surfaces of the container or from the device where the sealed source is mounted or stored where one might expect contamination to accumulate. Leak testing is conducted by HP. The test is capable of detecting the presence of 0.005 μCi or more of removable contamination, or if a plutonium source has been damaged or broken, the source will be deemed to be loosing plutonium.

USEC will immediately withdraw the sealed source from use and repair or dispose of the source, if determined to be leaking. Within five days after determining that any source has leaked, USEC will file a report with the Director, Nuclear Material Safety and Safeguards, describing the source, test results, extent of contamination, apparent or suspected cause of source failure, and corrective action taken. A copy of the report will be sent to the NRC Regional Administrator, Region III.

The periodic leak test does not apply to sealed sources that are stored and not being used. The sources excepted from this test will be tested for leakage prior to any use or transfer to another person unless they have been leak tested within six months, or three months for a sealed plutonium source, prior to the date of use or transfer.

4.8.4 Radiation Protection Instrumentation

Radiation dose rate and contamination survey instruments are selected to measure the types and energies of radiation encountered with gas centrifuge enrichment operations. As such, there is little need for a wide range of instruments. However, survey instruments capable of supporting radiography operations are maintained in inventory.

The primary complement of instrumentation includes alpha/beta count rate and scaler instrumentation plus ion chambers used to evaluate shallow dose and deep dose equivalent readings. Table 4.8-2 describes typical instrumentation available to support the operation of the Lead Cascade.

The RPM is responsible for maintaining adequate quantities of calibrated radiation detection and measurement instruments.

Radiological portable instruments are calibrated based on specifications derived from applicable vendors manuals and other nationally recognized guidance as appropriate (e.g., National Council on Radiation Protection 112). The standards found in the American National Standards Institute (ANSI) N323 (1978) are followed except for Sections 4.6 and 5.1(3). The following requirements apply to all such equipment and instruments:

- Portable radiation detection and measurement instruments are inspected, maintained, and calibrated at least annually or removed from service.
- Instruments are calibrated following any maintenance, modification, or repair deemed likely to affect operation before being returned to service.
- Calibration sources and equipment used for dose rate instruments are within 5 percent (at 2 sigma) of the stated value and have documented traceability links to the NIST. Large area uranium slab sources are certified to 10 percent by NIST. Calibration sources used to calibrate contamination-monitoring equipment are within 20 percent (at 2 sigma) for activity and 10 percent (at 2 sigma) for surface emission rate.
- Portable HP instruments that are in use but do not have a built in automatic functional test feature are source checked daily prior to noon that day, or prior to using the instrument if not used on a daily basis. Instruments with the automatic functional test feature that are in use are checked once a week.

4.8.5 Records and Reports

Radiological protection records demonstrate the effectiveness of the overall program and document personnel exposure. Records are maintained in the form required by 10 CFR 20.2110 and are retained as required by 10 CFR 20.2101 through 20.2106.

Reports and notifications of RP issues are made as required by 10 CFR Part 20, Subpart M. Details of reporting and notification for Lead Cascade incidents are described in Section 11.6 of this license application.

Table 4.8-1
Posting Criteria

AREA	CRITERIA	POSTING
Radiation Area measured at 30 cm	>0.005 rem/hr but ≤ 0.1 rem/hr	"CAUTION, RADIATION AREA" "TLD and RWP Required for Entry"
High Radiation Area measured at 30 cm	>0.1 rem/hour but ≤ 1.0 rem/hr	"CAUTION, HIGH RADIATION AREA" "TLD, Supplemental Dosimeter and RWP Required for Entry"
High Radiation Area measured at 30 cm	>1.0 rem/hr	"DANGER, HIGH RADIATION AREA" "TLD, Supplemental Dosimeter and RWP Required for Entry"
Very High Radiation Area measured at 1 m	> 500 rads/hr	"GRAVE DANGER, VERY HIGH RADIATION AREA" "Special Controls Required for Entry" "Contact PSS Before Entry"
Contamination (Removable)	Levels > 1 time but ≤ 100 times Table 4.6-1 values	"CAUTION, CONTAMINATION AREA" "RWP Required for Entry"
High Contamination (Removable)	Levels >100 Times Table 4.6-1 values	"CAUTION, HIGH CONTAMINATION AREA" "RWP Required for Entry"
Fixed Contamination[a]	Removable Contamination < Table 4.6-1 levels and total contamination levels > Table 4.6-1 column 3 values	"CAUTION, FIXED CONTAMINATION AREA"
Airborne Radioactivity Area	Levels 0.1 Times Table 4.7-4 DAC values	"CAUTION, AIRBORNE RADIOACTIVITY AREA" or "CAUTION AIRBORNE RADIOACTIVITY AREA" "Respiratory Protection Required"
Contamination Control Zone	Levels normally less than Table 4.6-1 removable column values with potential to exceed Table 4.6-1 removable column values	"CAUTION, CONTAMINATION CONTROL ZONE"
Radioactive Material Area or Radioactive Material Storage Area[b]	An amount of radioactive material used or stored exceeding 10 times the quantity of such material specified in 10 CFR Part 20, Appendix C	"CAUTION" "Radioactive Material Area" or "Radioactive Material Storage Area"

[a]If the area has been sealed with contrasting fixatives or alternative methods and labeled in accordance with methods approved by the RPM, the area is exempt from posting as a Fixed Contamination Area.

[b]Areas posted as a Contamination Control Zone, Contamination Area, High Contamination Area, Airborne Radioactivity Area, Radiation Area, High Radiation Area, or Very High Radiation Area need not be posted as Radioactive Materials Area.

Table 4.8-1 (continued)
Posting Criteria

Definitions

Airborne Radioactivity Area (ARA) — Any area where the measured concentration of airborne radioactivity, above natural background, may be reasonably expected to exceed either: (1) 10 percent of the DAC sampled over 8 hours, (2) a peak concentration of 1 DAC sampled over no more than 1 hour, or (3) soluble uranium concentration exceeds 50 $\mu g/m^3$ averaged over 8 hours.

Contamination Area (CA) — An area where transferable contamination levels are greater than the release limits stated in Table 4.6-1, but less than or equal to 100 times those limits.

Contamination Control Zone (CCZ) — An area where transferable contamination levels are less than the release limits stated in Table 4.6-1. CCZs are essentially buffer zones established where discrete areas of contamination may be occasionally encountered as a result of facility size.

Fixed Contamination Area (FCA) — An area containing radioactive material that cannot be readily removed from surfaces by nondestructive means, such as casual contact, wiping, brushing, or washing.

High Contamination Area (HCA) — An area where transferable contamination levels are greater than 100 times the limits stated in Table 4.6-1.

High Radiation Area (HRA) — An area, accessible to personnel, in which radiation levels could result in a person receiving a dose equivalent in excess of 0.1 rem Deep Dose Equivalent (DDE) in 1 hour at 30 cm from the radiation source or 30 cm from any surface that the radiation penetrates.

Radiation Area (RA) — An area, accessible to personnel, in which radiation levels could result in a person receiving a dose equivalent in excess of 0.005 rem DDE in 1 hour at 30 cm from the source or from any surface that the radiation penetrates.

Radioactive Material Area (RMA) — An area or structure where radioactive material is used, handled or stored.

Restricted Area — An area, to which access is limited for the purpose of protecting individuals against undue risk from exposure to radiation and radioactive materials.

Very High Radiation Area (VHRA) — An area, accessible to personnel, in which radiation levels could result in a person receiving an absorbed dose in excess of 500 rads in one hour at 1 meter from a radiation source or 1 meter from any surface that the radiation penetrates.

Table 4.8-2
Radiological Protection Instrumentation and Capabilities

Instrument	Manufacturer	Use	Detection Limit
LB5100	Tennelec	Air sample counting and Removable contamination sample counting	alpha - 4 pCi beta-gamma - 8 pCi alpha- 20 dpm/100 cm^2 beta-gamma - 40 dpm/100 cm^2
LB1043AS	Berthold	Personnel contamination monitoring	5,000 dpm/100 cm^2 total contamination[a]
PCM2	Eberline	Personnel contamination monitoring	5,000 dpm/100 cm^2 total contamination
Ludlum 12 with GM probe	Ludlum	Alpha personnel contamination monitoring and removable contamination surveys	100 cpm above background[b]
Ludlum 12 with alpha scintillator	Ludlum	Beta-gamma personnel contamination monitoring and removable contamination surveys	100 cpm above background[b]
REM 500	Health Physics Instruments	Neutron Dose/Dose Rate	0.001 rem (rad)/hr - 999 rem (rad)/hr
Teletector	Eberline	Beta-gamma Dose/Dose rate	0 mR/hr - 1000 R/hr
RO2	Ludlum	Beta-gamma Dose/Dose rate	0 mR/hr - 5 R/hr

a. The Berthold Monitors are set to alarm with 95 percent confidence upon detection of less than or equal to 5,000 dpm total contamination per detector. The actual detection limits are approximately 3-sigma above background, and depends on detector size, efficiency, background, and count time.

b. Personnel are trained in Radiation Worker Training to notify HP when contamination is detected greater than 100 counts per minute (cpm) above background. The maximum acceptable background count rate is 300 cpm.

c. Minimum calibration frequency is annual or manufacturer recommendations.

The instruments listed above are used for routine operations. Additional instruments are available to support emergency response.

4.9 References

1. ASME N509-1989, *Nuclear Power Plant Air-Cleaning Units and Components*

2. ASME N510-1989, *Testing of Nuclear Air-Treatment Systems*

3. ANSI N323-1978, *Radiation Protection Instrumentation Test and Calibration*

4. Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*

5. NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*

6. Regulatory Guide 8.13, Revision 2, *Instructions Concerning Prenatal Radiation Exposure*